DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

Prepared for*:*

Prepared by*:*

MACTEC

MACTEC Engineering and Consulting, Inc.
511 Congress Street
Portland, Maine 04101

JANUARY 13, 2006

DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

TABLE OF CONTENTS

DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

TABLE OF CONTENTS

ACRONYMS

REFERENCES

FIGURES

TABLES

APPENDICES

DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

LIST OF FIGURES

DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

LIST OF TABLES

DRAFT
STATISTICAL EVALUATION OF BACKGROUND
AND SITE-SPECIFIC DATA
FALL 2004 AND SPRING 2005 PHASE 1A REMEDIAL INVESTIGATION DATA

NUCLEAR METALS SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
CONCORD, MASSACHUSETTS

LIST OF TABLES

1.0   INTRODUCTION

As stated in the Work Plan for the Nuclear Metals, Incorporated Superfund Site in Concord, Massachusetts (NMI Site), a characterization of background conditions is necessary to complete the Remedial Investigation (RI), to complete the risk assessment and support risk management decisions, to facilitate evaluation of disposal issues for radionuclides, and to support the Feasibility Study (FS).

This memorandum provides the statistical evaluation of analytical data collected at six background reference areas for the NMI Site:

1. Soil samples collected from the Stow Town Forest, which will be used as a background reference for soil at the NMI Site.
2. Surface water and sediment samples collected in a reach of the Assabet River upstream of the Site, which will be used as a background reference area for portions of the Assabet River that are proximal to the Site.
3. Surface water and sediment samples collected from the Maynard High School fire pond (Maynard Pond), which will be used as a background reference area for the Cooling Water Pond (Area of Investigation [AOI] 4 at the NMI Site).
4. Surface water and sediment samples collected from a peat bog in the Town of Hudson (Hudson Bog), which will be used as a background reference area for the Sphagnum Bog (AOI 6 at the NMI Site).
5. Surface water and sediment samples collected from a wetland area approximately 1.2 miles northeast of Acton town center (Conant Well Property), which will be used as a background reference area for the Northeast Wetland (AOI 10 at the NMI Site).
6. Groundwater samples collected from upgradient locations at the NMI Site, which will be used as background for site groundwater (AOI 16 at the NMI Site)

The background data evaluated in this memorandum were collected during the NMI Fall 2004 and Spring 2005 Phase 1A RI field programs. The analytical data represent conditions in background or upgradient samples, or samples from selected areas considered representative of the types of environments at or near the site. The background reference locations were identified in Technical Memorandum - Wetland Delineation and Identification of Background Sampling Areas submitted to United States Environmental Protection Agency (USEPA) Region I in summer 2004 and included in this report as Appendix A.   Representatives from USEPA visited the background locations and subsequently gave approval of the proposed background locations. The background or upgradient data collected from these reference areas included:

- A set of ten surface water samples collected along an approximately 2,800-foot long stretch of the Assabet River immediately upstream of the Site (see Figure 2). These samples were analyzed primarily for volatile organic compounds, and total and dissolved metals and specialty metals (molybdenum, thorium, titanium,

tungsten, uranium, and zirconium). These data will be used to evaluate potential impact of the Site on the Assabet River by comparison with river samples taken adjacent to and downstream from the site. These samples were labeled SWRI17001000 through SWRI17010000.

- A set of ten sediment samples corresponding to the locations of the upstream surface water samples collected from the Assabet River. These samples were also analyzed primarily for Volatile Organic Compounds (VOCs) and total and specialty metals. These data will be used to evaluate potential impact of the Site on the Assabet River by comparison with river samples taken adjacent to and downstream from the site. These samples were labeled SDRI17001000 to SDRI17010000.

- A set of 15 surficial soil samples collected from a representative background forested setting in the Town of Stow (see Figure 3). This area was determined to have soil with geological characteristics similar to the soil at the Site. These data will be used to evaluate potential impact from the Site on soil at and adjacent to the NMI property. These samples were analyzed primarily for semivolatile organic compounds (SVOCs), including polynuclear aromatic hydrocarbons (PAHs), metals, and specialty metals. These samples were labeled SSRI17001000 through SSRI17015000.

- A set of ten sediment samples collected from a pond environment (Maynard Pond, see Figure 4) that will be used as background reference samples to evaluate the AOI 4 Cooling Water Pond sediment. These samples were analyzed primarily for SVOCs, PAHs, metals, and specialty metals. These samples were labeled as SDRI17026000 through SDRI17035000.

- A set of five surface water samples collected from a pond environment (Maynard Pond) that will be used as background reference samples to evaluate the AOI 4 Cooling Water Pond surface water. These samples were analyzed for total and dissolved metals and specialty metals. These samples were labeled SWRI17026000 through SWRI17030000.

- A set of 15 sediment samples collected from a peat bog environment (Hudson Bog, see Figure 5) that will be used as background reference samples to evaluate the AOI 6 Sphagnum Bog sediment. These samples were analyzed primarily for SVOCs, PAHs, metals, specialty metals, and acid volatile sulfide/simultaneously extracted metals (AVS/SEM). These samples were labeled as SDRI17011000 through SDRI17025000.

- A set of 10 surface water samples collected from a peat bog environment (Hudson Bog, see Figure 5) that will be used as background reference samples to evaluate the AOI 6 Sphagnum Bog surface water. These samples were analyzed primarily for metals, specialty metals, and hardness. These samples were labeled as SWRI17011000 through SWRI17013000, SWRI17015000, SWRI17017000, SWRI17019000, SWRI17021000, and SWRI17023000 through SWRI17025000.

- A set of 10 sediment samples collected from a wetland environment (Conant Well Property, see Figure 6) that will be used as background reference samples to evaluate the AOI 10 Northeast Wetland sediment. These samples were analyzed

primarily for SVOCs, PAHs, metals, and specialty metals. These samples were labeled as SDRI17037000, SDRI17039000 through SDRI17041000, SDRI17043000, and SDRI17046000 through SDRI17050000.

- A set of three surface water samples collected from a wetland environment (Conant Well Property, see Figure 6) that will be used as background reference samples to evaluate the AOI 10 Northeast Wetland surface water. These samples were analyzed primarily for metals, specialty metals, and hardness. These samples were labeled as SWRI17046000, SWRI17049000, and SWRI17050000.

- A set of four groundwater samples collected from monitoring wells located upgradient from the NMI Site that will be used as background reference samples to evaluate the AOI 16 groundwater. These samples were analyzed primarily for field parameters (pH, conductivity, turbidity, temperature, etc.), metals, specialty metals, VOCs, SVOCs, PAHs, FS parameters, fluoride, and nitrate.

The sample sets collected from the Assabet River at reaches adjacent to and downgradient of the Site during the Fall 2004 RI field program consisted of:

- A set of ten surface water samples collected from the Assabet River in areas adjacent to the Site that would be anticipated to be potentially impacted by the Site through runoff and/or groundwater discharge (see Figure 1). These samples were analyzed primarily for VOCs and total and dissolved metals and specialty metals. These samples were labeled SWRI18008000 through SWRI18017000.

- A set of ten sediment samples collected from the Assabet River at locations corresponding to the surface water samples collected from the Assabet River at areas adjacent to the Site. These samples were analyzed primarily for VOCs and metals and specialty metals. These samples were labeled SDRI18008000 through SDRI18017000.

- A set of five surface water samples collected from the Assabet River at a reach approximately 2,000 to 4,350 feet downstream from the Site (see Figure 1). These samples were analyzed primarily for VOCs, and total and dissolved metals and specialty metals. These samples were labeled SWRI18018000 through SWRI18022000.

- A set of five sediment samples collected from the Assabet River at locations corresponding to the surface water samples collected from the Assabet River at areas downstream from the Site. These samples were analyzed primarily for VOCs, metals, and specialty metals. These samples were labeled SDRI18018000 through SDRI18022000.

Subsets of background/upgradient and downgradient samples were also analyzed by radiochemical methods to permit evaluation of the radioisotopic speciation of thorium and uranium. The results of the radioisotopic evaluation are presented in the Draft Radiological Assessment - Fall 2004 Remedial Investigation Data (September, 2005).

The specific objectives of the statistical evaluations for the background reference areas included in this memorandum are:

- To establish values representative of background conditions (i.e., 'background values'). Those values will be used with risk-based screening levels to derive Remedial Investigation Screening Levels (RSLs) for the purposes of delineating the nature and extent of contamination at the Site;
- To determine if surface water and sediment quality in portions of the Assabet River adjacent to and downstream of the Site are quantitatively different from surface water and sediment quality in portions of the Assabet River upstream of the Site.

This report is organized as follows. Section 2 provides an overview of the general characteristics of the data sets evaluated in this assessment. Section 3 describes the statistical evaluations performed to characterize the data sets and to calculate upper measures of the data sets. Section 4 provides recommendations for upper measures of background that may be used to establish RSLs for the purposes of delineating the nature and extent of contamination. Section 5 provides sample group evaluations for Assabet River surface water and sediment. The technical approach used to perform this background evaluation is consistent with the approach for background assessment that was described in the Final Field Sampling Plan submitted to the USEPA on September 29, 2005. Details on the collection of the samples will be provided in the Draft RI Report.

2.0   GENERAL OBSERVATIONS ABOUT THE NATURE OF THE DATA SETS

Table 1 presents a summary of the parameters that were analyzed in the various background data sets evaluated in this assessment. Tables 2 through 20 present summary statistics for each of the data sets evaluated in this assessment.   Tables presenting analytical results for all compounds with at least one detection per sample set are contained in Appendix B.

Assabet River Upstream Surface Water: This data set contained only two VOCs: low concentrations of methyl ethyl ketone (MEK) and trace amounts of methyl tertbutyl ether (MTBE). No chlorinated solvents were detected in the water column although some low concentrations of these compounds were detected in associated sediments. Total metals analyses generally showed a greater number of parameters detected than in the dissolved analyses as well as higher concentrations, including elements that might be considered associated with the NMI site (e.g., thorium and uranium). Exceptions to this were the presence of arsenic in dissolved analyses and none in total, and a higher frequency of detection for uranium in the dissolved analyses versus the totals analysis (6/10 and 1/10, respectively).   More maximum concentrations were detected in sample SWRI17002000 than in any other sample.

Assabet River Upstream Sediment: This data set contained a number of chlorinated solvents in addition to MEK and MTBE. Detected concentrations range from single digit micrograms per kilogram (µg/kg) to as high as 46.4 µg/kg for trichloroethene (TCE). Numerous metals were detected. Maximum concentrations detected were distributed among a number of samples.

It should be noted that neither the Assabet River upstream surface water nor upstream sediment samples should be considered true background, as they are obviously impacted by other sources in this urban setting. The river receives runoff as well as groundwater discharge from locations other than NMI. Further, Route 62 runs along the river south bank, quite closely at some locations, and this may result in impacts to the river (e.g., sodium from winter road-salting measures).

Assabet River Site Surface Water: This data set contained MEK and MTBE, but at typically lower concentrations than in upstream samples. TCE was also present, but only at trace concentrations. Again, total metal analyses had a greater number of elements detected, at typically higher concentrations, than dissolved (filtered) samples. Selenium and mercury were detected in the dissolved analyses and not the total analyses, but at low frequency of detection and low concentration. Maximum concentrations were distributed across a number of samples, although more appeared to be associated with SWRI18013000. All of the Site and Downstream surface water and sediment samples have a potential of being adversely impacted by the W.R. Grace Site, which has documented contaminant plume migration toward and into the Assabet River.

Assabet River Site Sediment Samples: This data set contained a reduced number of VOCs detected, consisting primarily of chlorinated solvents. Concentrations were relatively low, and two compounds were detected only once each in ten samples. Nearly all metals were detected in ten of ten samples, the exceptions being selenium (one of ten) and tungsten (nine of ten). Maximum concentrations were distributed across a number of samples, but with SDRI18011000 appearing to have the greatest number.

Assabet River Downstream Surface Water Samples: This data set contained only MEK and MTBE at approximately the same concentrations as the Site samples. As with the surface water samples in general, the total metals analysis yielded a greater number of analytes detected than did the dissolved (filtered) samples, as well as generally higher concentrations. An exception was zirconium, which was detected in the dissolved analysis, but not in the total analysis. Zirconium was detected in only one of five samples, however. Maximum concentrations were distributed among a few samples, with the most for total analyses being in sample SWRI18022000, and the most for dissolved concentrations in sample SWRI18018000.

Assabet River Downstream Sediment Samples: In addition to MEK and 1,1-DCE (trace), these samples contained carbon disulfide (2 of 5 samples), toluene (trace, 1 of 5 samples) and acetone (5 of 5 samples). Acetone was detected at concentrations up to 214 µg/kg, and MEK up to 46 µg/kg. All metals detected were present in five of five samples with the exception of antimony at three of five samples. Maximum concentrations for analytes were fairly equally distributed among the three middle samples, (e.g., SDRI18019000, SDRI18020000 and SDRI18021000).

Surficial Soil Forest Samples: Metals were broadly represented in this set although some metals were not detected (e.g., antimony and thallium), and some metals were reported at low frequency of detection (e.g., cadmium was detected in only two of fifteen samples). Maximum concentrations for the metals were fairly evenly distributed among approximately five samples. SVOC analysis by Method 8270C produced detections of nine compounds, mostly PAHs whereas analysis by Method 8310 (specifically for PAHs) detected only five compounds. Concentrations in the Method 8270 analyses were higher than the 8310 counterparts, as were detection limits. Detection limits in sample SSRI18015000 for Method 8270C had extremely elevated detection limits due to a large detected concentration of bis(2-chloroethyl)ether. Inclusion of this sample for those compounds not detected, (i.e., using a ½ detection limit value for these compounds) could lead to strongly biased results as frequency of detections varied from two to eleven in fifteen samples

Surface Water Maynard Pond Samples: This data set of five samples includes analyses for total and dissolved metals and specialty metals. Only a limited number of elements (nine) were detected in both the total and dissolved analyses. Further, they were not the same nine; arsenic, manganese, and vanadium were detected in the dissolved analyses and not the total analyses. Calcium and mercury were reported present in total analyses, but not in

dissolved analyses. There were no detections for total uranium, thorium or zirconium in any samples. Maximum concentrations for total metals were found mostly in sample SWRI17027000, while for dissolved analyses the maximum concentrations were distributed more evenly across all samples.

Sediment Maynard Pond Samples: The analysis for metals in sediments showed a broad range of detected elements, including thorium, uranium and zirconium. Frequencies of detection were relatively high for most elements. Maximum concentrations were mostly distributed among five samples with each having between four and seven of the maximum concentrations. Analyses for SVOCs indicated Method 8270C reported a greater number of compounds (mainly PAHs) at higher concentrations and with a greater magnitude and range of detection limits than for the Method 8310 (PAH) results. Frequencies of detection were fairly high for most compounds except for most of the non-PAH compounds that were reported by Method 8270C. Sample SDRI17030000 had most of the maximum concentrations reported for the compounds by 8270C, while the maximum concentrations by Method 8310 were mostly (seven of eleven maximums) found in sample SDRI17031000.

Surface Water Conant Well Property Samples: This data set of three samples includes analyses for total and dissolved metals and specialty metals. The majority of analytes were detected in all three samples and in both total and dissolved analyses. Beryllium and vanadium were not detected in dissolved analyses. There were no detections for thorium or zirconium in any samples.

Sediment Conant Well Property Samples: The analysis for metals in sediments showed a broad range of detected elements, including thorium, uranium and zirconium. Frequencies of detection were relatively high for most elements. Maximum concentrations were mostly distributed among three samples (SDRI17046, 17049, and 17050). Analyses for SVOCs indicated Method 8270C and Method 8310 reported essentially the same PAHs (Method 8310 reported benzo(a)anthracene, whereas Method 8270C did not), but Method 8270C generally reported PAHs at higher concentrations and with a greater magnitude and range of detection limits.

Surface Water Hudson Bog Samples: This data set of ten samples includes analyses for total and dissolved metals and specialty metals. The majority of analytes were detected in all ten samples and in both total and dissolved analyses. Silver and tungsten were detected in total analyses but not in dissolved analyses, and mercury was detected in dissolved analyses but not in total analyses. There were no detections for thorium in any samples. Eight of the maximum detected concentrations (total and dissolved) were associated with sample SWRI17013000.

Sediment Hudson Bog Samples: Sediment samples collected from Hudson Bog were initially segregated into peat and sediment based on sample log information. Peat was defined as material primarily consisting of organic peat mat generally partially submerged

(or totally un-submerged) beneath surface water. Sediment was defined as material primarily consisting of inorganic substrate entirely submerged beneath surface water. The differentiation between peat and sediment was performed to match the sampling protocol used at the Sphagnum Bog (AOI 6), in which samples of peat, sediment, and sphagnum (identified as the living portion of the peat mat) were collected. The intent of the sampling at Hudson Bog was to collect substrates that matched those collected at Sphagnum Bog. However, the portion of Hudson Bog that could be sampled as a background reference area did not provide the same variability of substrates that were sampled at Sphagnum Bog[1]. Specifically, the area that could be sampled at Hudson Bog was primarily peat interspersed with non-contiguous areas of shallow standing water; no sphagnum material was present. Consequently, the sediment data set for Hudson Bog is comprised of 11 peat samples and 4 sediment samples. As discussed in subsection 3.2, these data were ultimately pooled to create a more statistically robust background data set.

Most of the metals analyzed for, including uranium and thorium, were detected at a high frequency in both peat and sediment samples. More SVOCs were detected in peat samples and at slightly higher concentrations that in sediment samples. Maximum concentrations of several parameters were associated with samples SDRI17013, 17021, and 17024.

---

[1] The Hudson Bog is on several properties owned by different parties. Permission to collect samples could only be gained at one of the properties, and at that property, sampling had to be performed at an area that was not potentially influenced by the adjacent railroad right-of-way. Consequently, the portion of the Hudson Bog available for sampling was limited in both areal extent and substrate.

3.0 APPROACHES TO STATISTICAL EVALUATIONS OF THE DATA

Statistical evaluation of the data sets included data exploration, computation of basic statistics, examination for possible outliers, determination of underlying distributions, calculation of upper confidence limits on the data set mean or median, and calculation of suitable measures of upper limits for the background data.

Statistical evaluations were conducted in accordance with USEPA and other statistical guidance, including:

- EPA, 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance.*
- EPA, 1992. *Draft Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Final Guidance.*
- EPA, 1995. "Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites".
- EPA, 1997. *Data Quality Evaluation Statistical Toolbox (DataQUEST) User's Guide.*
- EPA QA/G-9D, QA96 Version.
- EPA, 2000. *Guidance for Data Quality Assessment: Practical Methods for Data Analysis: EPA QA/G-9: QA00 Update.*
- EPA, 2002. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Site: EPA 540-R-01-003.*
- EPA, 2004. *ProUCL Version 3.0 User Guide.* EPA/600/R04/079, April 2004.
- U.S. Navy, 1998. *Procedural Guidance for Statistically Analyzing Environmental Background Data.* Prepared by SWDIV and EFA WEST of Naval Facilities Engineering Command, September 1998.
- U.S. Navy, 1999. *Handbook for Statistical Analysis of Environmental Background Data.* Prepared by SWDIV and EFA WEST of Naval Facilities Engineering Command, July 1999.

Statistical evaluations were primarily carried out using ProUCL (USEPA, 2004), ChemStat Version 4.0 (Starpoint Software), NCSS 2001 and PASS 2000 (Hintze, 2001), and Excel 2003 spreadsheets (Microsoft). Some computations were performed by hand as selected checks on the software results, and where concentration ranges exceeded the capabilities of algorithms within the software. Results were assembled into Excel spreadsheets and are presented as tables in this report. Software outputs and hand calculations are included as Appendices C (ProUCL outputs), D (hand calculations of Poisson tolerance limits), and E (t-Test and Wilcoxon Rank Sum Test results).

Details of the evaluation procedures and results are discussed in the following sections.

3.1   DATA EXPLORATION AND BASIC STATISTICS

Data explorations and basic statistics give a feel for the character of the data and a sense of the best method for statistical evaluation of each data set and/or analyte. In addition, the basic statistics allow results for total and dissolved metals and Methods 8270C and 8310 to be compared, lending information to select the most appropriate methods for handling possible variants in results. Exploration of the data permitted identification of compounds that were not detected in any of the samples. Further statistical evaluation then focused only on parameters and data sets for which at least one positive detection was recorded. Table 1 provides a summary of the parameters that were analyzed in the data sets evaluated in this assessment as well as an indication of which data sets the parameters were detected. The outcome of the basic statistics and data exploration are presented in Tables 2 through 20.

Basic statistics were performed using ProUCL (v. 3.02) and Access/Excel algorithms. The ProUCL output summary sheets are contained in Appendix C. Data exploration and basic statistics included determination of the frequency of detection, visualization of the spread of the data by parameter, and computation of the arithmetic mean, standard deviation, coefficient of variation and skewness of the data. Data sets immediately assigned non-parametric status due to low frequency of detection generally do not have basic statistics provided in the respective accompanying tables. Further, the computation of mean and standard deviation for many parameters should not be construed as indicating a parametric distribution; these were computed to aid in the determination of a proper distribution (if any) for each of the parameters where frequency of detection limits was met.

The data sets contained no rejected data, and estimated values (flagged "J") were treated the same as other detected values. Since environmental data are typically censored (have some results reported as non-detects), non-detect results were replaced with one-half of the reported detection limit for those results for these calculations. Other methods, such as trimmed means and standard deviations, would result in effectively decreasing the size of the background data set. Further, many of the methods for dealing with censored data assume an underlying normal distribution; this assumption is frequently incorrect when dealing with environmental data.

3.2   POOLING OF DATA SETS

With the exception of Hudson Bog sediment data, pooling of data sets was not performed because of the distinct objectives of maintaining separate background/upgradient data sets, and because simple inspection of the data sets suggested that pooling of data sets was not appropriate. For example, it was clear that the signature and concentrations of compounds and elements for upgradient/background surface water samples for the Assabet River and Maynard Pond were significantly different. Similarly, results for sediment samples were distinct between groups as were the results on the same samples by Methods 8270C and

8310 for PAHs. The environments characterized by pond and river are characteristically different and should be represented by their own data sets.

Due to the limited size of the sediment data set for Hudson Bog, the peat and sediment data sets were reviewed to determine if they could be pooled, thus creating a data set with higher statistical power that could be used to evaluate both sediment and peat data sets for Sphagnum Bog. The Wilcox Rank-Sum (WRS) test, which evaluates if the medians of the two sample sets are the same, was used to determine if the data sets were sufficiently similar to allow pooling (Appendix E). The results of the WRS test indicated that the sample data sets were not significantly different and, therefore, the peat and sediment data sets could be pooled into a single data set.

3.3   DETERMINATION OF UNDERLYING DISTRIBUTION

Several tests for underlying normality or log-normality of a data set are available, including screening criteria, such as the coefficient of variation (ratio of the standard deviation to the mean) and skewness. However, for data sets consisting of less than 50 values, EPA guidance appears to favor the Shapiro-Wilk test. Conducting the test produces a test statistic which may then be compared to a tabulated critical statistic for the number of samples in the data set and the desired level of confidence. If the test statistic is greater than the critical value, then the null hypothesis that the data came from a normal distribution cannot be rejected at the specified level of confidence. Note this is not the same as proving that the underlying distribution is, indeed, normal. If the raw data fail the normality test, then a log-transform may be performed on the data and the test repeated. In this way, an assumption of an underlying log-normal distribution may be tested. Data not passing the tests for normality or log-normality may be treated with non-parametric statistical methods.

The USEPA has expanded determination of the underlying distribution by introducing testing for a possible gamma distribution. The basis for this is in work by Singh and Singh, and is enabled in the EPA software ProUCL, which provides several basic statistical procedures aimed at providing a best estimate of a 95 percent upper confidence limit (UCL) on the mean of the data. ProUCL has been used in this analysis to provide the determination of underlying distribution for each of the parameters in each of the data sets. If ProUCL determines that none of normal, log-normal, or gamma distributions is appropriate, then the data set is treated by non-parametric methods.

Another factor that enters the consideration of the determination of underlying distribution (if any) is the frequency of detection. USEPA guidance recommends that any parameter with less than 50 percent frequency of detection be treated as non-parametric. Further, guidance indicates that if the frequency of detection drops below 10 percent, a suitable assumption should be that the data set exhibits a Poisson distribution, and a 95 percent upper tolerance limit can be computed (ChemStat, based on the USEPA statistical guidance, has an option to compute this limit). In several instances, the frequency of

detection was 10 percent (1 in 10 samples). In this instance, a Poisson distribution has been assumed, and a 95 percent coverage, 95 percent confidence upper tolerance limit computed through ChemStat, or by hand (section 3.5.3).

While gamma distributions were assigned for the purpose of computing a 95 percent UCL on the mean, the other computations were completed with gamma replaced by non-parametric, as there is no guidance on determining upper limits of other types for a gamma distribution.

The distributions determined by these methods are presented in Tables 2 through 20.

3.4   OUTLIER TESTING

Outliers are data values that appear to be either anomalously higher or lower than the remainder of the data set. There are several tests for apparent outliers, including visual tests such as box and whisker plots and numerically based tests such as Dixon's and the Discordance Tests. Apparent extreme values are compared to the likelihood that the value could belong to the assumed normal distribution (or log-normal distribution when transformed). Some tests automatically test for a number of the apparent high or low values, and others may be applied successively with each apparent outlier removed from the set. For data sets with fewer than 25 samples, USEPA guidance recommends Dixon's Test for outliers. This test is included within the ChemStat software.

An apparent outlier value may occur if, for example, the underlying distribution is not normal, there was an error in computing the data value, or the sample was mis-labeled. The apparent outlier may be further tested using a log-transformation of the data; log-normality of the data is the most frequent cause for an apparent outlier in the raw data. Data records may be checked to verify proper identification and reporting of results. Beyond this, guidance suggests retaining any data point that cannot be verified as in error as a possible extreme value that may be encountered during sampling. Another recommended approach is to run a test with and without the apparent outlier included to see what bearing this value may have, if any. Frequently, non-parametric methods are relatively insensitive to the magnitude of extreme values.

Dixon's test for outliers was used as applied in ChemStat for all of the data sets. First, the test was applied to untransformed data, and then, if the value was a suspected outlier, retested using a log-transform of the data.

Results of the outlier testing are presented as Table 21. Approximately one-half of the apparent outliers were discarded when the data were log-transformed. Several other apparent outliers were determined to be due to very small standard deviations where there was a higher proportion of non-detects and detection limits were consistent. Very few of the apparent outliers appeared to be extreme outliers after log-transformation. These were identified and data management records were reviewed for any apparent errors; none were

identified. Most of the remaining outliers, then, had no basis for their disqualification from the data sets. It was noted that the total metals in the surface water samples exhibited considerable variability and were a disproportionate source of outliers. This may be due to variation in suspended solids (sediment) that affects total metals results in surface water. Due to the variability observed in the total metals surface water data, it is recommended that comparisons of site to upgradient surface water samples be based on use of dissolved metals concentrations only.

The following outliers were removed (Table 21):
- The extreme value of approximately 6 milligrams per kilogram (mg/kg) uranium in the upgradient Assabet River sediment sample (SDRI17004000) was identified as an outlier, as this could significantly affect comparisons and inferences made when comparing downgradient or potentially site-impacted samples. The summary statistics presented in Table 5 provide evaluation with and without this sample.
- Sample SSRI17015000 in the forest surficial soil set with SVOCs by Method 8270C was identified as an outlier. This sample has extremely high detection limits compared to other samples in this set, and all compounds were non-detect except for bis (2-chloroethyl) ether. This sample has been removed from this data set (still leaving 14 samples for a basis for comparison). All other values are retained in the data sets.
- In the Conant Well Property sediment samples, the maximum concentrations of barium and sodium, as well as the lowest and highest concentrations of benzo(a)anthracene and chrysene, and the highest concentrations of fluoranthene and pyrene (all by Method 8310) were identified as outliers and were removed from the data sets.
- In the Hudson Bog peat and sediment (combined) data set, the extreme outlier of 15,700 ug/kg diethylphthalate was removed, as well as the maximum concentration of potassium, which was identified as an outlier.

3.5 MEASURES OF MEAN, MEDIAN AND UPPER LIMITS ON THE DATA

Various measures of the mean, median and upper limits on the data may be derived from the statistics computed on the background and other data sets. One of the most prominent statistics from a risk assessment standpoint is a 95 percent UCL on the mean. This statistic is intended to provide a conservative estimate of the arithmetic mean concentration and, therefore, is not suitable for use as a representative upper-limit of the background data. While guidance focuses mainly on comparison of groups of samples representing some potentially affected area versus background, it is also useful, particularly for defining extent of site impact, to obtain some reasonable measure of the expected upper limit of the background or upgradient data with which to compare individual potentially site-impacted samples. Several such measures are suggested in the literature. These include the 95th percentile on the data, the 95 percent coverage, 95 percent confidence upper tolerance limit (95/95 UTL), the sample mean plus three standard deviations, and the maximum value of

the data set (all for each parameter). These are discussed in greater detail below. Since guidance does not provide methods of estimating these upper limits for distributions identified as gamma by ProUCL, they were estimated assuming non-parametric methods. Results of the computed upper limit measures for upgradient or background samples are included in Tables 2, 5 and 8 through 20; each of the respective measures of upper limits is discussed in the following paragraphs.

3.5.1   95 Percent Upper Confidence Limit on the Mean

EPA guidance defines specific methods of computation of the one-sided 95 percent UCL for normal, log-normal and non-parametric distributed data. The 95 percent UCL on the mean for normally distributed data is given by:

$$95\% \, UCL = xbar + t_{0.95,n-1} * SD/(n)^{\wedge}0.5$$

where xbar = the sample set arithmetic mean,
$t_{0.95,n-1}$ = the Student-t table value for 95 percent confidence and n-1 degrees of freedom, and
SD = standard deviation of the untransformed data
n = the number of samples.

For a log-normal distribution, the method developed by Land is recommended in the guidance, and the formula used is:

$$95\% \, UCL = \exp(ybar + 0.5(s_y)^2 + s_y H_{.95}/(n-1)^{\wedge}0.5)$$

where ybar = the sample mean of the log-transformed data,
s_y = the sample standard deviation of the log-transformed data,
n = the number of samples in the data set, and
$H_{.95}$ = a factor dependent on sample size and the log-transformed standard deviation.

ProUCL was used to generate most of the 95 percent UCLs on the mean. In addition, recent developments implemented in the ProUCL software provide additional methods for estimating an upper limit for the mean. One is based on the identification of an underlying gamma distribution, while others depend on multiple re-sampling of the data with replacement. These other methods include bootstrap and jackknife approaches. Several others are provided as well. Where ProUCL offered a recommended UCL on the mean, it was included in the results table. Tables 2 through 20 summarize the recommended 95 percent UCL on the mean and identify the method applied as recommended by ProUCL or by other decision criteria where ProUCL is not applicable.

ProUCL is recommended as limited to data with a high frequency of detection, but has been used to derive 95 percent UCL values for all normal, log-normal, non-parametric, and

gamma distributions. For instances where a non-parametric distribution is indicated and the frequency of detection is less than 50 percent, a 95 percent UCL on the mean could be provided through order statistics.

3.5.2   95th Percentile

The 95th percentile on the data for normally distributed data is computed by:

$$95^{th} \text{ Percentile} = xbar + t_{0.95,n-1}*SD$$

where xbar = the sample set arithmetic mean,
   $t_{0.95,n-1}$ = the Student-t table value for 95 percent confidence and n-1 degrees of freedom, and
   n = the number of samples.

Similarly, the 95th percentile for log-normally distributed data may be obtained by substituting the log-transformed values of mean and standard deviation. Guidance suggests that comparison tests be done using the log-transformed data, however, the value provided in the table has been transformed back into the raw data form to provide an easier comparison with downgradient sample data.

For non-parametric data, the method consists of determining the 95th percentile with 95 percent confidence using the binomial tables (see Conover, 1980). As Conover notes, at this level of confidence, the method requires at least 20 samples before the method provides an estimate of less than the highest ordered sample. In other words, until at least 20 samples are available, the method will result in selecting the maximum value of the data set.

3.5.3   95 Percent Coverage, 95 Percent Upper Tolerance Limit

A 95 percent coverage, 95 percent confidence tolerance limit (95/95 UTL) provides an upper limit based on available data that we would expect any future samples from this data set to fall within 95 percent of the time with 95 percent confidence. This measure, when it can be calculated, probably provides the best measure of background for purposes of determining extent of contamination (i.e., comparing single site-related samples to background).

For normally or log-normally (using log-transformed data) distributed data, this calculation is similar to that for the 95th percentile of the data:

$$95/95 \text{ UTL} = xbar + K*s_x$$

where xbar = the sample set arithmetic average,
       s_x = the sample set standard deviation, and

K = the one-sided 95 percent coverage, 95 percent confidence tolerance limit factor dependent on sample size.

The K-value is somewhat greater than that of the Student t-value or normal Z-value for a comparable data set size and level of confidence; Gibbons (1994) provides tables of one-sided and two-sided 95/95 tolerance limits. The ChemStat software provides computation of the distributional UTLs. Again, the UTL for log-normally distributed data, obtained by substituting the mean and standard deviation for the log-transformed data in the above equation, has been transformed back into the original form for ease of comparison.

For non-parametric data, a large number of samples (greater than 50) is required to provide the estimate of a 95/95 UTL (Conover, 1980). Since the largest data set collected for this project is 15 samples, no estimates of 95/95 UTLs can be made for non-parametric data through the use of order statistics.

For frequencies of detection less than 10 percent, guidance suggests that a Poisson upper tolerance limit may be estimated for the data. This is a fairly complicated computational method (EPA, 1992), but it is programmed into the ChemStat software. However, the software has limitations within its computational algorithm and 95/95 UTLs for the data sets with Poisson distributions evaluated in this assessment have been computed by hand in many instances. 95/95 UTLs have been generated for parameters with frequencies of detection less than and including 10 percent in order to provide another upper limit measure for consideration. It should be noted that this method may provide slightly different 95/95 UTLs depending on the concentration units. This is due to the non-linearity of the Chi-square distribution (used in the calculations) and the presence of a constant in the equations which is not concentration unit dependent. The units of concentration have been adjusted for several parameters to provide total counts and parameter arguments more in the range suggested by guidance examples. The 95/95 UTLs should be considered approximate values or estimates (as is the case for any of the other statistics computed from sample sets).

3.5.4   Mean Plus 3 Standard Deviations

This measure may be applied to normally and log-normally distributed data. The log-normal value has been transformed back into original units for ease of comparison. The mean plus 3 standard deviations is approximately equal to the 95% percentile of the data set if the data are normally distributed??????

3.5.5   Maximum Detected

This is simply the maximum detected concentration (value) in the background/upgradient data set. It should be noted that the maximum of the data set may not necessarily be a good estimate of the maximum of the population or of an upper tolerance limit, and for the case of few parameters and data sets, it may be quite different and/or even biased low.

3.6   ASSUMPTIONS

Assumptions for the various statistical tests conducted in this evaluation vary according to test. Common assumptions or requirements for several of the tests include independent, randomly distributed and non-spatially correlated (by group) samples. Further desirable characteristics include equal variances, matching distribution types when comparing groups, and modestly variable detection limits (if frequency of detection < 100 percent). These characteristics often need to be examined before applying tests, and may require alternate statistical methods for evaluation.

3.6.1   Censored Data

For environmental samples where data are often censored (actual concentrations may be below some method detection limit or sample quantitation limit), an assumption must be made concerning the concentration that may actually be present in the sample (ranging between not present and just below the detection limit). The approach recommended by EPA and most commonly accepted in environmental assessments is to assume that actual concentrations are present at a value equal to one-half the sample quantitation limit. For samples where concentration ranges may result in varying detection limits that may exceed estimated concentration values reported for some other samples within the same data set, ordering may result in values of half the detection limit exceeding the highest reported actual or estimated concentration. This is not a favorable situation, but is inevitable due to laboratory dilutions and the use of a validated data set. While no current alternatives are offered here, the occurrence of such a condition is noted below. This occurs for the following data sets and analytes:

- Surface water, Assabet River, Site samples: MEK, total arsenic, and total vanadium.
- Sediment, Assabet River, Upstream samples: carbon disulfide
- Sediment, Assabet River, Site samples: 1,1-DCA
- Sediment, Assabet River, Downstream samples; 1,1-DCE and toluene
- Sediment, Maynard Pond by 8270C: Acenaphthylene, benzoic acid, dibenz(a,h)anthracene and dibenzofuran
- Forest soil by 8270C: Benzoic acid
- Forest soil by 8310: Phenanthrene

Fortunately, few – if any - of these compounds are likely to be Site-related.

3.6.2   Method 8310 and Method 8270C Results

USEPA Method 8310 is designed specifically for detection of trace levels of PAHs, while Method 8270C is more suitable for low to high levels of SVOCs, including PAHs. Method

8310 utilizes a UV detector for primary identification and a fluoresence detector for confirmation of PAHs. These detectors are fairly ambiguous and do not provide nearly the degree of certainty that is afforded by the 8270C GC/MS method. Combined with the lower quantitation limits, Method 8310 can result in more false positive results than 8270C. However, Method 8310 was used for analysis to meet the Project Action Levels (PALs), which are based on risk-based screening levels (RBSLs), for sediment, surface water, and to a lesser degree soil (i.e., 8310 was selected primarily because it provides lower quantitation limits for PAHs than does Method 8270C). Although there were some anomalous situations in comparing the two methods for the Maynard Pond sediment and Forest soil sample PAH results (some PAHs were detected and reported by 8270C and not by 8310, even though 8310 had lower detection limits), Method 8270C is the preferred method for quantifying PAH concentrations in samples for which sample quantitation limits by Method 8270C meet PALs. For sample results by Method 8270C that do not meet PALs, Method 8310 (which generally has lower detection limits), is the preferred method for quantifying PAHs.

A review of the soil data by Method 8270C (Table 12) and Method 8310 (Table 13) indicates that for PAHs that were detected by both methods, the detection limits for Method 8270 met PALs. Therefore, background data for PAHs in soil will be based on results by Method 8270C.

Even though Method 8310 was used for sediment samples to meet the PALs, this method is subject to interferences and is not considered as quantitative as Method 8270C at the PAH concentrations detected in sediment samples (generally 0.5 mg/kg to 5 mg/kg). In addition, with respect to detection limits meeting PALs, there were essentially no differences between Method 8270C and Method 8310 (i.e., for a given PAH, detection limits by both methods either met PALs or did not meet PALs). Therefore, background data for PAHs in sediment will be based on results by Method 8270C.

The PAH results by Method 8270C and Method 8310 in the validated fall 2004 Site data sets were also reviewed for comparability. Similar trends to those noted in the background data sets were observed; generally a greater number of PAHs were positively detected in the Method 8270C analyses than in the Method 8310 analyses, and detection limits associated with the Method 8270C analyses met PALs. Therefore, it has been recommended that PAH data for all Site and background data sets be represented by the Method 8270C analyses.

3.6.3   Maynard Pond Surface Water

Five samples of Maynard Pond surface water and analyzed for VOCs and metals. While this is a relatively small number, the standard deviations for the detected analytes were quite narrow and therefore should provide a reasonable basis for comparison with Site-related samples. When the Site-related samples are obtained, this limited number of samples should be assessed to assure that statistical analysis has sufficient power to

differentiate between groups. If not, then additional background samples may need to be obtained.

3.6.4   Conant Well Property Surface Water

Three samples of Conant Well Property surface water and analyzed for metals. This number of samples is too small to permit rigorous statistical analysis or derivation of statistically-based upper limit values. However, given that the standing water at the Conant Well Property encompasses a relatively small area and is present only seasonally, a data set of three samples is likely to provide an adequate representation of the surface water quality at the Conant Well Property. In addition, the Northeast Wetland (AOI 10), for which the Conant Well Property serves as a background reference area, has attributes that are very similar to the Conant Well Property (i.e., a limited area of standing water that is present only seasonally). Therefore, the surface water data set for the Conant Well Property is considered to be sufficient for its intended application as the background reference for the Northeast Wetland.

3.6.5   Total and Dissolved Surface Water Data

Total metals analyses in surface water appear to be affected by suspended solids. The use of total concentrations may create false positives and create larger variances that make determination of differences more tenuous. In addition, the surface water samples may be subject to seasonal effects (e.g., river flow, pond elevation, groundwater interaction). However, these differences may be minimized through use of data for dissolved analyses, which are not affected by suspended solids loads. Therefore, it is recommended that comparisons of Site and background surface water data be based on the dissolved concentrations only.

4.0   ESTABLISHING UPPER MEASURES OF BACKGROUND

One of the key objectives of the background evaluation is to establish values for each parameter in each background reference area that are representative of background conditions (i.e., 'background values'), for the purposes of delineating the nature and extent of contamination at the Site. The upper measures of background calculated in Section 3 are used to establish the background values. Upper measures of background are developed for all of the background reference areas evaluated in this memorandum.

The relative order of the upper measures may vary depending on number of samples in the data set and the standard deviation (SD) of the data set, but for a large sample set from a normal distribution, the upper measures would typically be ordered as:

$$95^{th} \text{ percentile} < 95/95 \text{ UTL} < \text{maximum} < \text{mean} + 3*SD.$$

With fewer than 10 samples, the 95/95 UTL will become greater than the mean + 3*SD. As the number of samples in the data set decreases, the maximum of the data set is less likely to adequately estimate the maximum of the population.

The statistical summary tables (Tables 2 through 20) frequently show the 95th percentile and 95/95 UTL exceeding the maximum detected value for distributions identified as normal or log-normal. Possible reasons for this may include: 1) the data sets are not precisely normally (or log-normally) distributed; 2) the limited number of samples leads to a potentially greater estimate of the variance (standard deviation); 3) the data set sample maximum is less likely to be a good estimate of the maximum of the population; and 4) the lower sample size has greater uncertainty as reflected in a greater t-value (for Student's t-distribution), Z-value (for normal distribution) or K-value (tolerance limit). Regardless of the specific reason(s) that the statistical measures exceed the maximum values, the statistical evaluations suggest that if additional samples were obtained, one might expect to measure higher concentrations than are presently represented by the maximum detected concentrations in the background data sets. Consequently, the minimum of these four measures represents a conservative upper limit of the background/upstream data set. It is recommended, then, that the minimum of these four measures be used as a conservative upper limit of the background/upstream data set.

The recommended upper limit of background, for use in evaluating Site data via comparison of individual Site samples to background/upstream conditions, is the minimum of the 95 percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations. Tables 22 through 24 summarize the recommended background upper limit values for sediment (Assabet River upstream, Maynard Pond, Conant Well Property, and Hudson Bog reference areas), surface water (Assabet River upstream, Maynard Pond, Conant Well Property, and Hudson Bog reference areas), and soil (Stow Town Forest reference area).

5.0 EVALUATION OF ASSABET RIVER DATA

One of the key objectives of the background evaluation for the Assabet River is to determine if surface water and sediment quality in portions of the Assabet River adjacent to and downstream of the Site are quantitatively different from surface water and sediment quality in portions of the Assabet River upstream of the Site. The upstream Assabet River surface water and sediment data were used to evaluate the Site and downstream data by group analysis and by comparison of downstream and Site data to the upstream upper limit values shown in Section 4.0. If the RI determines that the Assabet River has been impacted by the Site, then the upper limit background values derived in Section 4.0 could be used to help delineate the nature and extent of contamination.

5.1 GROUP COMPARISONS

The statistical methods presented in this section test the hypothesis that the means (or medians) of the two sample sets are the same. The unpaired two sample t-Test may be used when the underlying distributions are the same, e.g., both normally distributed, and when variances are similar (t-Tests include equal variance and unequal variance versions). The equality of variances may be compared through an F-Test or, as recommended in guidance, Levene's Test for Equal Variance. The t-Test results in a T-value which may be compared to a critical statistic to see if the means differ statistically or not. In comparing to the critical value, a two-sided interval is created such that we are looking for the t-Test statistic magnitude (absolute value) to be less than the critical statistic for equality of means to be accepted. When the number of samples is small, the distributions between the two sets do not match, or there is a large discrepancy between variances of the two sample sets, non-parametric comparisons are usually considered best. EPA guidance suggests using the WRS Test. The WRS test evaluates if the medians of the two sample sets are the same, and, based on the data, results in a W-statistic (some texts use a U-statistic related to the equivalent Mann-Whitney Test). This W-statistic is compared to tabulated critical values of the W-statistic for 95 percent confidence and the numbers of samples in each of the two data sets. For these present evaluations, the NCSS and PASS software (Hintze, 2001) was used to conduct the t-Tests and WRS Tests. Results of these group comparisons are presented in Tables 26 through 29. Table 25 identifies differences in analyte detections among Assabet River upstream, Site, and downstream samples.

It is important to note that failure of the test (rejection of the hypothesis of equal means or medians) may indicate that the means or medians are just different. It may be the case, and, as it is for some parameters, that downgradient samples show statistically significantly lower concentrations than upgradient samples. These types of results are pointed out in the Comments section of Tables 26 through 29.

In addition, some of the changes in analyte concentrations between groups may be the result of sources other than the NMI Site. Results of the WRS and two-sample t-Tests (Tables 26 through 29) indicate for which parameters, in comparing Assabet River Site and Downstream samples with Upstream, the means (parametric) or medians (non-parametric)

of the respective sets are statistically different. These tables also indicate the results for Levene's Test for Equal Variance.

For surface water samples, only the dissolved sample results are used for comparisons, as there appeared to be too much interference with suspended solids for total metals to provide reliable measures of true difference.

5.1.1   Surface Water Assabet River – Upstream with Site

T-Tests were performed on four analyte data set pairs (both upstream and downstream distributions were shown to be normal for each of the four analytes). Two results (see Table 26), calcium and potassium, indicated no difference in means; these results were matched by the WRS test results. The t-Test for barium showed the means to be different, with the upstream sample having a greater mean concentration; the WRS Test result mirrored this also. The fourth t-Test, for magnesium, indicated a statistically significant difference in the means (Site lower mean) while the WRS indicated no difference. For magnesium, the relatively low standard deviations produce this result while the difference in the means is only about 5 percent.

For the WRS tests, six tests showed the Site data medians/means to be lower than the upstream, only two tests indicated higher Site means/medians than upstream analytes (aluminum and lead), while all other analytes showed no difference in means and medians for these data compared as groups.

5.1.2   Surface Water Assabet River – Upstream with Downstream

T-Tests were performed for seven analytes whose distributions were both normal in each of the data sets (see Table 27). For barium, no significant differences were shown in means for upstream and downstream sample sets. However, the remaining six t-Tests indicated statistically significant differences in the means for up- and downstream sample sets. These were for MEK (downstream lower), calcium, magnesium, nickel, potassium, and sodium (all higher downstream). WRS Tests for these seven analytes agreed, except for magnesium, which failed the t-Test but met the WRS Test critical value, but only by slight margins. For six other analytes, the WRS Test indicated medians of the compared sets were different, with the median values downstream being statistically different but differing only in magnitude by 10 to 23 percent.

5.1.3   Sediment Assabet River – Upstream with Site

T-Tests were performed for eleven analytes for Upstream versus Site sediment samples (see Table 28). Ten of these showed no significant difference between means for the analytes tested, while for copper, the Site sample mean was significantly lower than that of the upstream sample set. Results of WRS Tests for all these analytes agreed with the t-Test results. The WRS Test for cadmium showed the Site sample set having a lower median

than the upstream sample set. All other results for WRS Tests indicated no significant differences in medians for each of the remaining analytes.

5.1.4   Sediment Assabet River – Upstream with Downstream

T-Tests were performed for eight analytes with normal distributions for both Upstream and Downstream sample sets (see Table 29). All eight results indicated no statistical difference in Upstream and Downstream data set means; the WRS Test results all concurred. Several parameters were detected in downstream samples but not in the upstream samples; these included acetone, MEK, toluene and selenium. All other WRS sample set comparisons showed no significant difference in medians.

5.2   COMPARISONS WITH RECOMMENDED UPPER LIMITS

Individual sample results in the Site and downstream surface water and sediment samples have also been compared to the recommended upper limits (the minimum of the 95th percentile, the 95/95 UTL, the maximum detected, and the mean plus three standard deviations) determined in report Section 4. These comparisons of individual samples with the recommended upper limits are summarized in tabular form as Tables 30 through 33, with individual sample results (detected concentrations) that exceed the recommended upper limit highlighted in gray. In addition, these tables also present the results of the group comparisons in the final column for easier reference.

For Assabet River surface water samples, only dissolved metal results were compared by parameter between the two sets (upstream with Site; and upstream with downstream) as there appeared to be too much interference with suspended solids for total metals to provide reliable measures of true difference.

5.2.1   Surface Water – Site Samples with Upstream

For five parameters in the Site sample set (TCE, copper, selenium, zinc and zirconium), upstream samples were all non-detect. Thus, any Site samples with detections of these analytes show as exceeding the recommended upper limits. Concentrations of these analytes, however, were relatively low (e.g., TCE with a maximum reported detection of 0.3 micrograms per liter). Several other parameters had one or more instances where Site sample results were higher than the recommended upper limit. These included aluminum, calcium, mercury, molybdenum, nickel, and uranium. In most cases, these exceeded the recommended upper limit only very slightly (e.g., uranium at 0.036 micrograms per liter (µg/L) versus the recommended upper limit of 0.027µg/L). For nine parameters, Site sample results were all less than the recommended upper limit.

For two of the Site surface water parameters with at least one value exceeding the recommended upper limit, the group comparison (WRS Test) showed a statistically significant difference (Site median greater than upstream). Five other parameters were detected in Site samples, but not in upstream samples.

5.2.2 Surface Water – Downstream Samples with Upstream

For four parameters in the downstream sample set (copper, selenium, zinc and zirconium), upstream samples were all non-detect. Thus, any downstream samples with detections of these analytes show as exceeding the respective recommended upper limits. Concentrations of these analytes, however, were relatively low (e.g., copper with a maximum reported detection of 2.9 µg/L). Several other parameters had one or more instances where downstream sample results were higher than the recommended upper limit. These included arsenic, calcium, manganese, molybdenum, nickel, potassium, sodium and uranium. In most cases, these exceeded the recommended upper limit only very slightly (e.g., arsenic at 2.2 µg/L, versus the upper limit of 1.8 µg/L). For seven parameters, Site sample results were all less than the recommended upper limit.

For nine of the downstream surface water parameters with at least one value exceeding the recommended upper limit, the group comparison (WRS Test) showed a statistically significant difference (downstream median greater than upstream). Four other analytes were detected in downstream samples, but not in upstream samples.

5.2.3 Sediments – Site Samples with Upstream

Comparisons between these two sets showed very few Site sample results greater than the recommended upper limits. Selenium was not detected in the upstream sediments and was only detected in one of ten Site samples (at 0.95 mg/kg). Chromium exceeded the recommended upper limit in two of ten samples and then by little (maximum detection of 58.5 mg/kg versus limit of 40.6 mg/kg). Mercury exceeded the limit in one of ten samples (0.66 mg/kg versus 0.13 mg/kg), but is a relatively low value. Uranium slightly exceeded the recommended limit of 2.2 mg/kg (calculated excluding an apparent outlier of 6 mg/kg). For 31 parameters, all Site sample results were below the recommended upper limit for comparison.

The group comparison (WRS Test) did not show a statistically significant difference (Site median greater than upstream) for any of the Site sediment parameters with at least one value exceeding the recommended upper limit. One analyte (selenium) was detected in Site samples (but only once in ten samples), but not in upstream samples.

5.2.4 Sediments – Downstream Samples with Upstream

Comparisons between these two sets showed a greater number of downstream sediment sample results greater than the recommended upper limits than did the Site samples. There were five parameters detected in downstream sediment samples that were not detected in the upstream set; these included acetone, MEK, toluene, antimony and selenium. While antimony, selenium and toluene concentrations were quite low, acetone was present in one sample at 214J µg/kg, and MEK at 45.8 µg/kg. For chromium, copper, iron, and zinc, a few samples were significantly greater than the recommended upper limit. For

molybdenum, silver, tungsten and zirconium, there were limited cases of exceeding the upper limit, and these were by slight margins. For 22 parameters, all Site sample results were below the recommended upper limit for comparison, including the lowered recommended limit for uranium (calculated excluding the maximum detected value of 6 mg/kg).

The group comparison (WRS Test) did not show a statistically significant difference (Site median greater than upstream) for any of the downstream sediment parameters with at least one value exceeding the recommended upper limit. Five of the analytes were detected in downstream samples, but not in upstream samples.

5.3   SUMMARY OF ASSABET RIVER BACKGROUND EVALUATION

Statistical evaluation of analyte concentrations in Assabet River Site and downstream samples, using concentrations reported in upstream stream samples, shows the following:

Site Sediment: Sporadic detections of four inorganics in Site sediment samples exceeded the background upper limit values. Among these analytes, selenium was not detected in the upstream sample set and, consequently, an upper limit for background was not established. However, sample group comparisons indicate that none of the analytes detected in Site sediment samples are present at concentrations that are statistically significantly higher than concentrations in upstream sediment samples[2].

Downstream Sediment: Twelve metals and four VOCs were detected in one or more downstream sediment samples at concentrations that exceeded the background upper limit values. Among these analytes acetone, MEK, toluene, antimony, and selenium were not detected in upstream samples. However, sample group comparisons indicate that only one metal (selenium) and three VOCs (acetone, carbon disulfide, and MEK) are present in downstream sediment samples at concentrations that are statistically significantly higher than concentrations in upstream sediment samples[3]. Of these analytes, acetone, MEK, and selenium were not detected in upstream sediment samples.

Site Surface Water: Eleven metals and one VOC were detected in one or more Site surface water samples at concentrations that exceeded the background upper limit values. Among these analytes, TCE, selenium, zinc, and zirconium were not detected in upstream surface water samples. However, sample group comparisons indicate that only two metals

---

[2] For selenium, this conclusion is based on statistical comparison of detected and non-detect values in Site samples to non-detect values in upstream samples; the statistical evaluation indicated that a statistically significant difference did not exist between the two data sets.

[3] For antimony and selenium, this conclusion is based on statistical comparison of detected and non-detect values in downstream samples to non-detect values in upstream samples; the statistical evaluation indicated that a statistically significant difference did not exist between the two data sets.

(aluminum and lead) are present in Site surface water samples at concentrations that are statistically significantly higher than concentrations in upstream surface water samples[4].

Downstream Surface Water: Thirteen metals were detected in one or more downstream surface water samples at concentrations that exceeded the background upper limit values. Among these analytes, copper, selenium, zinc, and zirconium were not detected in upstream surface water samples. Sample group comparisons indicate that eleven of these thirteen metals are present in Site surface water samples at concentrations that are statistically significantly higher than concentrations in upstream surface water samples.

---

[4] For TCE, selenium, zinc, and zirconium, this conclusion is based on statistical comparison of detected and non-detect values in Site samples to non-detect values in upstream samples; the statistical evaluation indicated that a statistically significant difference did not exist between the two data sets.

6.0   CONCLUSIONS/RECOMMENDATIONS

6.1   SOIL

Guidance suggests that comparison of Site and background data as sample groups is statistically more robust than comparison of single Site sample values to single background values. However, previous and on-going investigations have clearly demonstrated that soil at the Site has been affected by releases. Therefore, the investigation objectives for soil at the Site are to delineate the extent of the release(s); group comparisons of Site and background data sets are not appropriate for this objective. Rather, use of upper-measures of the background concentrations, in combination with risk-based screening levels, is more appropriate for delineating the extent of contamination.

Therefore, the upper limit value of each detected parameter in the background data set is recommended for establishing a background value for the purposes of delineation the nature and extent of contamination. The recommended upper limit is the minimum of the 95th percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations. Background upper limit values are presented in Table 24.

6.2   ASSABET RIVER

It is not definitive that the Site has impacted the Assabet River. Therefore, the investigation objectives for the Assabet River are to first determine if the Site has impacted the river, and then to define the extent of contamination if impacts are identified. Consequently, the principal objective of the Assabet River background assessment is to evaluate potential differences in sediment and surface water quality between upstream and Site/downstream samples. This was accomplished through use of group sample evaluations and comparisons of Site/downstream sample results to the background upper limit values (defined as the minimum of the 95th percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations). These evaluations concluded that:

- Concentrations of constituents in Site sediment samples are not significantly different from upstream sediment samples
- Concentrations of acetone, carbon disulfide, MEK, and selenium in downstream sediment samples are significantly higher than concentrations in upstream sediment samples.
- Concentrations of aluminum and lead in Site surface water samples are significantly higher than concentrations in upstream surface water samples.
- Concentrations of aluminum, calcium, cobalt, copper, lead, molybdenum, nickel, potassium, sodium, uranium, and zinc in downstream surface water samples may be significantly higher than concentrations in upstream surface water samples. However, this conclusion has a higher degree of uncertainty than the other Assabet River evaluations due to the limited downstream data set (five samples) and the temporal variability inherent in river surface water quality.

6.3   MAYNARD POND

Maynard Pond will be used as the background reference area for the on-property Cooling Water Pond (AOI 4). Since surface water and sediment data for the Cooling Water Pond are not yet available, the background assessment only presents upper limit background values at this time. The recommended upper limit for Maynard Pond surface water and sediment is the minimum of the 95th percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations. The upper limit values for surface water and sediment at Maynard Pond are presented in Tables 22 and 23. These upper limit background values may be used, in combination with risk-based screening levels, to evaluate the extent of contamination in the Cooling Water Pond. However, group comparisons of Cooling Water Pond surface water and sediment data and Maynard Pond surface water and sediment data may eventually be performed to supplement that evaluation.

6.4   CONANT WELL PROPERTY

The Conant Well Property will be used as the background reference area for the on-property Northeast Wetland (AOI 10). The recommended upper limit for Conant Well Property surface water is the maximum detected concentration, since the surface water data set is not large enough to permit calculation of other statistical measures of upper limits. However, given the small areal extent and intermittent nature of surface water in both the Conant Well Property and the Northeast Wetland, the surface water data set for the Conant Well Property is considered to be adequate for its intended uses. The recommended upper limit for Conant Well Property sediment is the minimum of the 95th percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations. The upper limit values for surface water and sediment are presented in Tables 22 and 23. These upper limit background values may be used, in combination with risk-based screening levels, to evaluate the extent of contamination in the Conant Well Property. In addition, group comparisons of Northeast Wetland sediment data and Conant Well Property sediment data may eventually be performed to supplement that evaluation.

6.5   HUDSON BOG

Hudson Bog will be used as the background reference area for the on-property Sphagnum Bog (AOI 6). The recommended upper limit for Hudson Bog surface water and sediment is the minimum of the 95th percentile, 95/95 UTL, maximum of the data set, or the mean plus three standard deviations. The upper limit values for surface water and sediment at Hudson Bog are presented in Tables 22 and 23. These upper limit background values may be used, in combination with risk-based screening levels, to evaluate the extent of contamination in the Sphagnum Bog. The combined peat and sediment background data set for Hudson Bog may be used to evaluate both peat and sediment (separately) at the Sphagnum Bog. Group comparisons of Sphagnum Bog surface water and sediment data

and Hudson Bog surface water and sediment data may eventually be performed to supplement that evaluation. In addition, the Screening Level Ecological Risk Assessment (SLERA) will further evaluate the suitability of the Hudson Bog reference area (area that was sampled) as a reference area for more advanced ecological risk assessment studies; potential data gaps will be identified.

ACRONYMS

AOI	Area of Investigation
FS	Feasibility Study
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram
MTBE	methyl tertbutyl ether
NMI Site	Nuclear Metals, Inc., Superfund Site in Concord, Massachusetts
PAH	polynuclear aromatic hydrocarbon
PALs	Project Action Levels
RBSLs	risk-based screening levels
RI	Remedial Investigation
RSLs	Remedial Investigation Screening Levels
SD	standard deviation
SLERA	Screening Level Ecological Risk Assessment
SVOC	semivolatile organic compound
TCE	trichloroethylene
UCL	upper confidence limit
µg/L	microgram per liter
µg /kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WRS	Wilcox Rank-Sum

REFERENCES

Beyer, W., 1991. CRC Standard Probability and Statistics; Tables and Formulae. CRC Press, Boca Raton, FL.

Breckenridge, R. and A. Crockett, 1995. "Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites", EPA/540/S-96/500, December 1995.

Conover, W.J., 1980. Practical Nonparametric Statistics, second edition. John Wiley & Sons, Inc., New York.

EPA, 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance*

EPA, 1992. *Draft Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Final Guidance*, Office of Solid Waste, USEPA, Washington. D.C.

EPA, 1997. *Data Quality Evaluation Statistical Toolbox (DataQUEST) User's Guide*. EPA QA/G-9D, QA96 Version.

Gibbons, R.D., 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons, Inc., New York.

Gilbert, R.O., 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

Hintze, J., NCSS and PASS. Number Cruncher Statistical Systems. Kaysville, Utah. www.NCSS.com

Singh, A., A.K. Singh, and R. Maichle, 2004. *ProUCL Version 3.0 User Guide.* EPA/600/R04/079, April 2004.

Starpoint Software, Inc., not dated. "ChemStat User's Guide, Version 4.0". For additional information see www.pointstar.com.

U.S. Navy, 1998. *Procedural Guidance for Statistically Analyzing Environmental Background Data.* Prepared by SWDIV and EFA WEST of Naval Facilities Engineering Command, September 1998.

U.S. Navy, 1999. *Handbook for Statistical Analysis of Environmental Background Data.* Prepared by SWDIV and EFA WEST of Naval Facilities Engineering Command, July 1999.

FIGURES

Figure 1
Background Sampling Locations
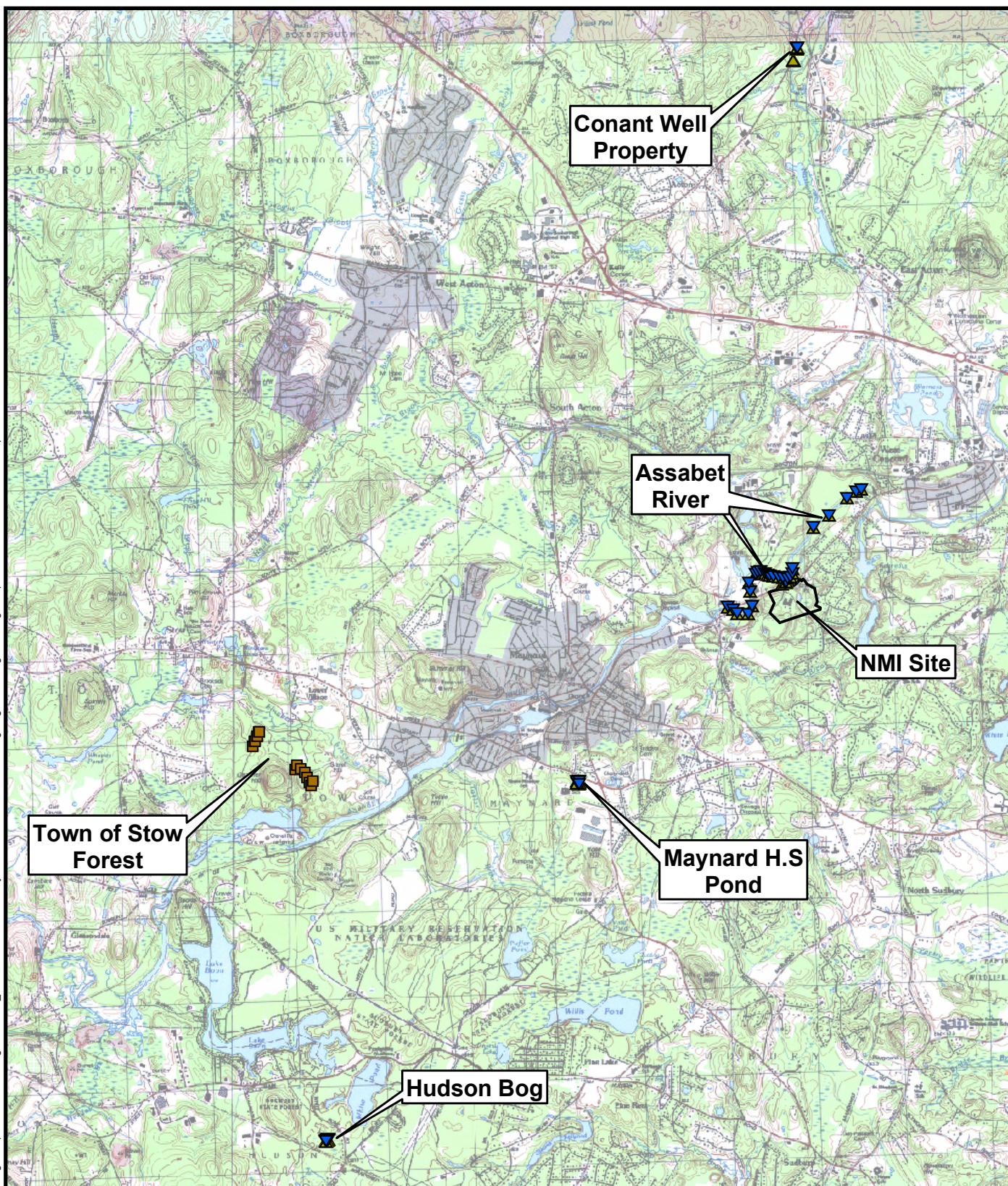
Legend
- ■ Surface Soil
- ▲ Sediment
- ▼ Surface Water

Conant Well Property

Assabet River

NMI Site

Town of Stow Forest

Maynard H.S Pond

Hudson Bog

N

0   0.5   1
Miles

Prepared by BRP   Checked by DRP

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

Document: P:\Projects\nuclear metals ri fs eeca\gis\mapdocuments\Background\NMI_8x11.mxd   PDF: P:\Projects\nuclear metals ri fs eeca\gis\figures\Background\Figure1.pdf   12/09/2005 3:21 PM   brpeters

Legend

△ Sediment

▽ Surface Water

NOTE: All Samples in the River are both Sediment and Surface Water

Figure 2
Assabet River Sample Locations

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

Prepared by BRP | Checked by DRP

Document: P:\Projects\nuclear metals ri fs eeca\gis\mapdocuments\Background\NMI_11x17L.mxd   PDF: P:\Projects\nuclear metals ri fs eeca\gis\figures\Background\Figure2.pdf   12/09/2005   2:35 PM   brpeters

SS-RI-17015
SS-RI-17014

SS-RI-17013
SS-RI-17012

SS-RI-17010
SS-RI-17011

SS-RI-17009

SS-RI-17002

SS-RI-17003
SS-RI-17001

SS-RI-17004

SS-RI-17005

SS-RI-17008
SS-RI-17006

SS-RI-17007

Legend

■ Surface Soil

Figure 3
Town of Stow Forest
Sample Locations

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

N
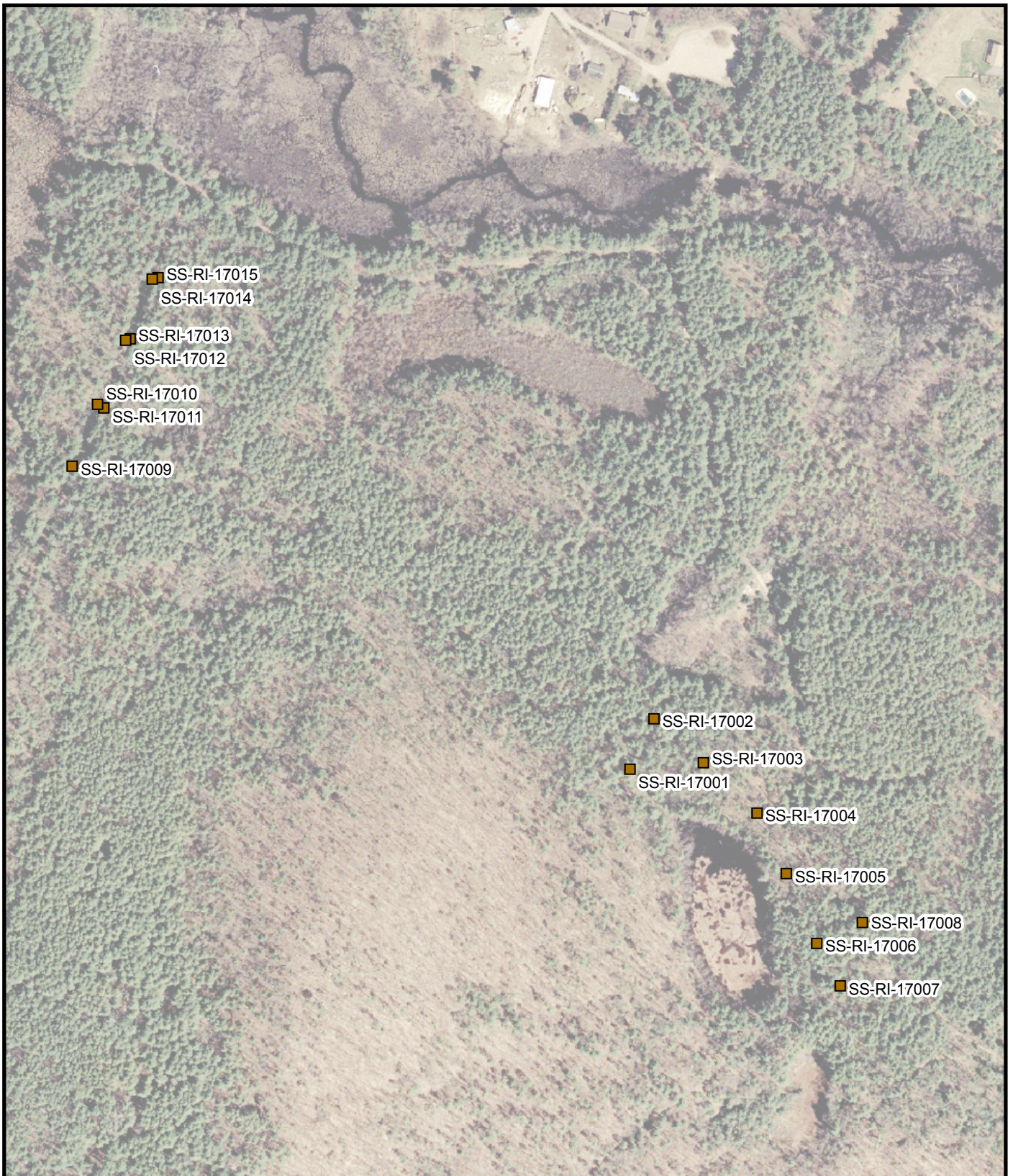
0   200   400
Feet

| Prepared by BRP | Checked by DRP |

Document: P:\Projects\nuclear metals ri fs eeca\gis\mapdocuments\Background\NMI_8x11.mxd   PDF: P:\Projects\nuclear metals ri fs eeca\gis\figures\Background\Figure3.pdf   12/09/2005 2:58 PM   brpeters

Legend
- ▲ Sediment
- ▼ Surface Water

Figure 4
Maynard High School Pond
Sample Locations

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

| Prepared by BRP | Checked by DRP |

N

0   20   40
Feet

Document: P:\Projects\nuclear metals ri f fs eeca\gis\mapdocuments\ri_field_program\ri_8x11.mxd   PDF: P:\Projects\nuclear metals ri f fs eeca\gis\figures\Background\Figure4.pdf   12/09/2005 2:33 PM   brpeters

Sample location labels:
- SD-RI-17031
- SD-RI-17029 / SW-RI-17029
- SD-RI-17028 / SW-RI-17028
- SD-RI-17027 / SW-RI-17027
- SD-RI-17032
- SD-RI-17026 / SW-RI-17026
- SD-RI-17033
- SD-RI-17035
- SD-RI-17030 / SW-RI-17030
- SD-RI-17034

Figure 5

Hudson Bog Sample Locations

Legend
Sediment
Surface Water

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

Prepared by BRP | Checked by DRP

Legend
△ Sediment
▽ Surface Water

Figure 6
Conant Well Property
Sample Locations

Nuclear Metals, Inc.
Concord, Massachusetts
MACTEC, Inc.

SW-RI-17050
SD-RI-17050

SD-RI-17047

SW-RI-17049
SD-RI-17049

SW-RI-17046
SD-RI-17046

SD-RI-17048

SD-RI-17043
SD-RI-17044
SD-RI-17045
SD-RI-17040
SD-RI-17042
SD-RI-17039
SD-RI-17038
SD-RI-17037
SD-RI-17036
SD-RI-17041

0   35   70
Feet

N

Prepared by BRP   Checked by DRP

TABLES

Table 1
Summary of Analytical Program for Background Reference Areas

Parameter	SW Assabet Up	SW Assabet Site	SW Assabet Down	SW Maynard	SW Conant	SW Hudson	SO Forest	SD Assabet Up	SD Assabet Site	SD Assabet Down	SD Maynard	SD Conant	Peat Hudson	SD Hudson
Volatile Organics Compounds														
1,1,1-Trichloroethane	✓	✓	✓	NA	NA	NA	NA	--	--	✓	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,1,2-Trichloroethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,1-Dichloroethane	✓	✓	✓	NA	NA	NA	NA	--	--	✓	NA	NA	NA	NA
1,1-Dichloroethene	✓	✓	✓	NA	NA	NA	NA	--	--	--	NA	NA	NA	NA
1,2,4-Trimethylbenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,2-Dibromoethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,2-Dichlorobenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,2-Dichloroethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,2-Dichloropropane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,3,5-Trimethylbenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,3-Dichlorobenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
1,4-Dichlorobenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Acetone	✓	✓	✓	NA	NA	NA	NA	✓	✓	--	NA	NA	NA	NA
Benzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Bromodichloromethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Bromoform	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Carbon disulfide	✓	✓	✓	NA	NA	NA	NA	--	✓	--	NA	NA	NA	NA
Carbon tetrachloride	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Chlorobenzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Chlorodibromomethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Chloroethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Chloroform	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Cis-1,2-Dichloroethene	✓	✓	✓	NA	NA	NA	NA	--	✓	✓	NA	NA	NA	NA
Cis-1,3-Dichloropropene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Dichlorodifluoromethane	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Ethyl benzene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methyl bromide	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methyl butyl ketone	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methyl chloride	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methyl ethyl ketone	--	--	--	NA	NA	NA	NA	✓	✓	--	NA	NA	NA	NA
Methyl isobutyl ketone	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methyl Tertbutyl Ether	--	--	--	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Methylene chloride	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Styrene	ü	ü	ü	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Tetrachloroethene	✓	✓	✓	NA	NA	NA	NA	--	--	✓	NA	NA	NA	NA
Toluene	✓	✓	✓	NA	NA	NA	NA	✓	✓	--	NA	NA	NA	NA
trans-1,2-Dichloroethene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Matrix of Detects.xls
NDs

Page 1 of 5

1/3/2006

Table 1
Summary of Analytical Program for Background Reference Areas

Parameter	SW Assabet Up	SW Assabet Site	SW Assabet Down	SW Maynard	SW Conant	SW Hudson	SO Forest	SD Assabet Up	SD Assabet Site	SD Assabet Down	SD Maynard	SD Conant	Peat Hudson	SD Hudson
trans-1,3-Dichloropropene	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Trichloroethene	✓	--	✓	NA	NA	NA	NA	--	--	✓	NA	NA	NA	NA
Trichlorofluoromethane	✓	✓	✓	NA	NA	NA	NA	--	✓	✓	NA	NA	NA	NA
Vinyl acetate	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Vinyl chloride	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Xylene, m/p	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Xylene, Ortho	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Xylenes, Total	✓	✓	✓	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA
Semivolatile Organics Compounds by 8270C														
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
1,4-Dioxane	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2-Chlorophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
2-Methylphenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	--	--
2-Nitroaniline	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
3,3`-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
4-Chloroaniline	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
4-Methylphenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	--	--
Acenaphthene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Acenaphthylene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Anthracene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	✓	--	✓
Benzo[a]pyrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	✓	✓
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	--
Benzo[ghi]perylene	NA	NA	NA	NA	NA	NA	ü	NA	NA	NA	--	ü	✓	✓
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	--	✓
Benzoic Acid	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	--
Bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	✓	✓	✓	--
Bis(2-Chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	--	✓	✓
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	--	✓

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Matrix of Detects.xls
NDs

Page 2 of 5

1/3/2006

Table 1
Summary of Analytical Program for Background Reference Areas

Parameter	SW Assabet Up	SW Assabet Site	SW Assabet Down	SW Maynard	SW Conant	SW Hudson	SO Forest	SD Assabet Up	SD Assabet Site	SD Assabet Down	SD Maynard	SD Conant	Peat Hudson	SD Hudson
Carbazole	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Chrysene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	✓
Dibenz[a,h]anthracene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Dibenzofuran	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Diethylphthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	--	--
Dimethylphthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Diphenylamine	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Fluoranthene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	--
Fluorene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	✓	✓
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Hexachloroethane	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	--	✓	✓
Isophorone	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Naphthalene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Nitrobenzene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
N-Nitrosodi-n-propylamine	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Pentachlorophenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	✓	✓
Phenanthrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	--
Phenol	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	--	--
Pyrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	--	--
Polyaromatic Hydrocarbons by 8310														
Acenaphthene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	NA	NA
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	NA	NA
Benzo[a]pyrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	NA	NA
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	--	NA	NA
Benzo[ghi]perylene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	NA	NA
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	--	NA	NA
Dibenz[a,h]anthracene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	--	✓	NA	NA
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	✓	NA	NA	NA	✓	✓	NA	NA

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Matrix of Detects.xls
NDs

Page 3 of 5

1/3/2006

Table 1
Summary of Analytical Program for Background Reference Areas

Parameter	SW Assabet Up	SW Assabet Site	SW Assabet Down	SW Maynard	SW Conant	SW Hudson	SO Forest	SD Assabet Up	SD Assabet Site	SD Assabet Down	SD Maynard	SD Conant	Peat Hudson	SD Hudson
Phenanthrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	--	--	NA	NA
Metals, Total														
Aluminum	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Antimony	✓	✓	✓	✓	✓	✓	✓	✓	✓	--	--	✓	✓	✓
Arsenic	✓	--	--	✓	✓	✓	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	✓	✓	✓	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	✓	✓	✓	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	✓	--	--	✓	--	--	--	--	--	--	--
Iron	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Mercury	--	✓	✓	--	✓	✓	--	--	--	--	--	--	--	--
Molybdenum	--	--	--	✓	✓	✓	--	--	--	--	--	--	--	--
Nickel	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	✓	✓	--	✓	✓	✓	✓	✓	--	--	✓	--	--	--
Silver	--	✓	✓	✓	✓	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	✓	--	--	--	--	--	--	--
Thallium	--	--	--	✓	✓	✓	--	--	--	--	--	--	--	--
Thorium	--	✓	✓	✓	✓	✓	--	--	--	--	--	--	--	--
Titanium	✓✓	✓	✓✓	✓	--	--	--	--	--	--	--	--	--	--
Tungsten	--	✓	✓	✓	✓	--	✓	--	--	--	--	--	--	--
Uranium	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Uranium-235 as Mass	--	--	--	--	--	✓	--	--	--	--	--	--	--	--
Uranium-238 as Mass	--	--	--	✓	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	✓	✓	--	✓	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	✓	--	--	--	--	--	--	--
Zirconium	✓	--	✓	✓	✓	--	✓	--	--	--	--	--	--	--
Metals, Dissolved														
Aluminum	--	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	--	--	--	--	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Barium	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Matrix of Detects.xls
NDs

Page 4 of 5

1/3/2006

Table 1
Summary of Analytical Program for Background Reference Areas

Parameter	SW Assabet Up	SW Assabet Site	SW Assabet Down	SW Maynard	SW Conant	SW Hudson	SO Forest	SD Assabet Up	SD Assabet Site	SD Assabet Down	SD Maynard	SD Conant	Peat Hudson	SD Hudson
Beryllium	✓	✓	✓	✓	✓	--	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	✓	✓	✓	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	--	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	✓	✓	✓	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	--	✓	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Copper	✓	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Iron	--	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Lead	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	--	--	✓	✓	✓	--	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	--	--	--	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	--	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	✓	--	--	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Silver	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	--	--	✓	✓	✓	--	NA	NA	NA	NA	NA	NA	NA	NA
Thorium	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Titanium	✓	✓	✓	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Tungsten	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	--	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235 as Mass	--	✓	✓	✓	--	✓	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238 as Mass	✓	✓	✓	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	--	✓	✓	--	✓	✓	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	✓	--	--	✓	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium	✓	--	--	✓	✓	--	NA	NA	NA	NA	NA	NA	NA	NA

✓ - Parameter not detected in this study area

-- - Parameter was detected in this study area

NA - Parameter not analyzed for in this study area

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Matrix of Detects.xls
NDs

Page 5 of 5

1/3/2006

Table 2
Summary Statistics
Assabet River Surface Water, Upstream

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
VOCs(MG/L)																		
Methyl ethyl ketone	6 / 10	60%	0.0065 :	0.02	0.0064 -	0.066	0.022	0.02	0.909	1.233	Normal	0.033776	Student's-t UCL	0.059	0.081	0.066	0.082	0.059
Methyl Tertbutyl Ether	3 / 10	30%	0.0005 :	0.0005	0.0003 -	0.00033	0.00025	0.000033	0.132	1.206	Non-parametric	0.00029	Modified-t UCL	0.00033	*	0.00033		0.00033
Total Metals (UG/L)																		
Aluminum	2 / 10	20%	12.5 :	153	916 -	4790	601.1	1497.6	2.491	2.981	Non-Parametric	3558.593	97.5% Chebyshev (Mean, Sd) UCL	4790	*	4790		4790
Barium	10 / 10	100%	:		16.2 -	89.1	26.37	22.6	0.857	2.908	Non-parametric	57.52168	95% Chebyshev (Mean, Sd) UCL	89.1	*	89.1		89.1
Beryllium	2 / 10	20%	0.025 :	0.025	0.038 -	0.28	0.042	0.084	2.000	3.111	Non-Parametric	0.20784	97.5% Chebyshev (Mean, Sd) UCL	0.28	*	0.28		0.28
Cadmium	2 / 10	20%	0.013 :	0.013	0.2 -	0.95	0.12	0.298	2.483	2.945	Non-Parametric	0.708379	97.5% Chebyshev (Mean, Sd) UCL	0.95	*	0.95		0.95
Calcium	10 / 10	100%	:		17400 -	20000	18580	725.4	0.039	0.142	Normal	19000.51	Student's-t UCL	19910	20692	20000	20756	19910
Chromium	2 / 10	20%	0.14 :	0.5	10.9 -	52.2	6.41	16.44	2.565	2.941	Non-parametric	58.14102	99% Chebyshev (Mean, Sd) UCL	52.2	*	52.2		52.2
Cobalt	9 / 10	90%	0.35 :	0.35	0.38 -	8	1.35	2.4	1.778	2.901	Non-parametric	6.084315	97.5% Chebyshev (Mean, Sd) UCL	8	*	8		8
Copper	1 / 10	10%	2.5 :	33.8	143 -	143	17.93	44.19	2.465		Poisson				27.5	143		14.3
Iron	9 / 10	90%	210 :	210	545 -	8690	1572.7	2574.1	1.637	2.868	Lognormal	3615.526	95% Chebyshev (MVUE) UCL			8690		
Iron (log-transformed)							6.673	1.1304						6279	21239	8690	23487	6270
Lead	6 / 10	60%	0.22 :	2	1.5 -	84.5	11.52	26.36	2.288	2.888	Lognormal	57.14299	99% Chebyshev (MVUE) UCL			84.5		
Lead (log-transformed)							0.6804	1.8718						61.0	459	84.5	542	61
Magnesium	10 / 10	100%	:		4260 -	5930	4630	471.6	0.102	2.796	Non-parametric	4925.347	Modified-t UCL	5930	*	5930		5930
Manganese	10 / 10	100%	:		48.7 -	483	118.8	133.5	1.124	2.759	Non-parametric	302.8431	95% Chebyshev (Mean, Sd) UCL	483	*	483		483
Mercury	2 / 10	20%	0.037 :	0.037	0.058 -	0.2	0.041	0.057	1.390	2.920	Non-parametric	0.119674	95% Chebyshev (Mean, Sd) UCL	0.2	*	0.20		0.2
Molybdenum	10 / 10	100%	:		1.5 -	2.5	1.75	0.28	0.160	2.639	Non-parametric	1.922059	Modified-t UCL	2.5	*	2.50		2.5
Nickel	4 / 10	40%	3.1 :	3.6	2.9 -	17.5	3.92	4.95	1.263	2.789	Non-Parametric	10.74325	95% Chebyshev (Mean, Sd) UCL	17.5	*	17.5		17.5
Potassium	10 / 10	100%	:		6330 -	7070	6709	237.3	0.035	0.107	Normal	6846.57	Student's-t UCL	7144	7400	7070	7421	7070
Silver	2 / 10	20%	0.004 :	0.049	0.34 -	1.7	0.214	0.532	2.486	2.964	Lognormal	0.931884	99% Chebyshev (MVUE) UCL	1.7	*	1.70		1.7
Sodium	10 / 10	100%	:		49000 -	65100	57070	6135	0.107	-0.102	Normal	60626.33	Student's-t UCL	68315	74929	65100	75475	65100
Thallium	1 / 10	10%	0.013 :	0.12	0.33 -	0.33	0.055	0.098	1.782		Poisson				0.125	0.33		0.125
Thorium	1 / 10	10%	0.019 :	0.2	0.7 -	0.7	0.1	0.21	2.100		Poisson				0.32	0.70		0.32
Titanium	3 / 10	30%	7 :	7	7.9 -	184	25.29	56.71	2.242	2.987	Non-Parametric	137.2762	97.5% Chebyshev (Mean, Sd) UCL	184	*	184		184
Tungsten	1 / 10	10%	0.17 :	2.4	5 -	5	0.765	1.523	1.991		Poisson				1.4	5		1.4
Uranium	1 / 10	10%	0.003 :	0.13	0.52 -	0.52	0.066	0.161	2.439		Poisson				0.125	0.52		0.125
Vanadium	2 / 10	20%	0.63 :	0.63	1.8 -	9.6	1.39	2.92	2.101	3.025	Non-Parametric	7.161526	97.5% Chebyshev (Mean, Sd) UCL	9.6	*	9.60		3.6
Zinc	2 / 10	20%	5.8 :	15.6	34.8 -	137	20.82	41.94	2.014	2.893	Non-Parametric	103.631	97.5% Chebyshev (Mean, Sd) UCL	137	*	137		137
Dissolved Metals (UG/L)																		
Aluminum	1 / 10	10%	4.3 :	15	85.4 -	85.4	12.67	25.61	2.021		Poisson				21.0	85.4		21
Arsenic	6 / 10	60%	0.96 :	0.96	1.1 -	1.8	1.08	0.56	0.519	-0.042	Non-parametric	1.851436	95% Chebyshev (Mean, Sd) UCL	1.8		1.8		1.8
Barium	10 / 10	100%	:		16.5 -	18.7	17.51	0.65	0.037	0.336	Normal	17.88413	Student's-t UCL	18.7	19.4	18.7	19.5	18.7
Calcium	10 / 10	100%	:		18000 -	19800	18950	613.3	0.032	-0.275	Normal	19305.51	Student's-t UCL	20074	20735	19800	20790	19800
Cobalt	6 / 10	60%	0.35 :	0.35	0.36 -	0.47	0.305	0.118	0.387	-0.099	Non-parametric	0.373162	Modified-t UCL	0.47	*	0.47		0.47
Iron	10 / 10	100%	:		188 -	627	306.2	135.1	0.441	1.618	G/NP	393.2335	Approximate Gamma UCL	627	*	627		627
Lead	1 / 10	10%	0.17 :	0.45	2.2 -	2.2	0.35	0.65	1.857		Poisson				0.8	2.2		0.8
Magnesium	10 / 10	100%	:		3820 -	4760	4286	319.4	0.075	-0.090	Normal	4471.16	Student's-t UCL	4871	5216	4760	5244	4760
Manganese	10 / 10	100%	:		50.8 -	93.7	60.68	12.19	0.201	2.627	Non-parametric	68.28171	Modified-t UCL	93.7	*	93.7		93.7
Mercury	1 / 10	10%	0.037 :	0.037	0.067 -	0.067	0.023	0.015	0.652		Poisson				0.06	0.067		0.06
Molybdenum	10 / 10	100%	:		1.6 -	1.7	1.68	0.042	0.025	-1.779	Non-parametric	1.703192	Modified-t UCL	1.7	1.8	1.7		1.7
Nickel	10 / 10	100%	:		3 -	3.3	3.13	0.11	0.035	-0.042	Normal	3.191409	Student's-t UCL	3.33	3.44	3.30	3.46	3.3
Potassium	10 / 10	100%	:		6160 -	7440	6755	349.6	0.052	0.201	Normal	6957.681	Student's-t UCL	7396	7773	7440	7804	7396
Sodium	10 / 10	100%	:		56700 -	67300	62010	3094.2	0.050	-0.061	Normal	63803.67	Student's-t UCL	67682	71017	67300	71293	67300
Thallium	1 / 10	10%	0.013 :	0.086	0.35 -	0.35	0.05	0.11	2.200		Poisson				0.195	0.35		0.195
Uranium	6 / 10	60%	0.003 :	0.003	0.003 -	0.027	0.00375	0.00381	1.016	2.232	Non-parametric	0.009001	95% Chebyshev (Mean, Sd) UCL	0.027	*	0.027		0.027
Vanadium	2 / 10	20%	0.63 :	0.63	0.91 -	0.95	0.44	0.26	0.591	1.785	Non-parametric	0.596133	Modified-t UCL	0.95	*	0.95		0.95

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.
  2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.
  3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833.
  4. The factor for a one-sided 95% coverage, 95% tolerance limit on 10 samples is 2.911.
  5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.
  6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.
  7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 3
Summary Statistics
Assabet River Surface Water, Site

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD
VOCs (MG/L)															
Methyl ethyl ketone	4 / 10	40%	0.001 : 0.018	0.00033 - 0.0035	0.0025	0.0029	1.160	1.518765	G/NP	0.005291	Approximate Gamma UCL	0.009	*	0.0035	
Methyl Tertbutyl Ether	7 / 10	70%	0.0005 : 0.0005	0.00026 - 0.0003	0.00027	0.000018	0.067	0.304	Normal	0.00028	Student's-t UCL	0.00030	0.00032	0.00030	0.00032
Trichloroethene	5 / 10	50%	0.0005 : 0.0005	0.00026 - 0.00032	0.00027	0.000025	0.093	1.790	Non-parametric	0.00028	Modified-t UCL	0.00032	*	0.00032	
Total Metals (UG/L)															
Aluminum	10 / 10	100%	:	38.5 - 66.6	54.18	7.44	0.137	-0.716	Normal	58.49202	Student's-t UCL	67.8	75.8	66.6	76.5
Arsenic	3 / 10	30%	0.96 : 3.5	0.98 - 1.1	1.11	0.51	0.459	-0.104	Normal	1.408285	Student's-t UCL	1.75	*	1.1	
Barium	10 / 10	100%	:	16 - 17.5	16.82	0.51	0.030	-0.467	Normal	17.11533	Student's-t UCL	17.8	18.3	17.5	18.4
Cadmium	1 / 10	10%	0.013 : 0.013	0.017 - 0.017	0.0076	0.0033	0.434	3.162	Non-parametric	0.00965	Modified-t UCL		0.014	0.017	
Calcium	10 / 10	100%	:	17800 - 19700	18720	731.5	0.039	0.066	Normal	19144.04	Student's-t UCL	20061	20849	19700	20915
Cobalt	10 / 10	100%	:	0.35 - 0.41	0.374	0.018	0.048	0.467	Normal	0.384654	Student's-t UCL	0.41	0.43	0.41	0.43
Copper	10 / 10	100%	:	3.3 - 9.3	5.08	1.875	0.369	1.363	Normal	6.166823	Student's-t UCL	8.52	10.54	9.30	10.71
Iron	10 / 10	100%	:	505 - 586	556.3	26.4	0.047	-0.945	Normal	571.6249	Student's-t UCL	604.7	633.2	586	635.5
Lead	7 / 10	70%	1.1 : 1.2	1.2 - 3.3	1.38	0.818	0.593	1.419	Normal	1.859499	Student's-t UCL	2.88	3.77	3.30	3.83
Magnesium	10 / 10	100%	:	4220 - 4770	4462	180.4	0.040	0.483	Normal	4566.55	Student's-t UCL	4793	4987	4770	5003
Manganese	10 / 10	100%	:	50.5 - 61.7	57.6	3.39	0.059	-0.990	Normal	59.53409	Student's-t UCL	63.8	67.4	61.7	67.8
Molybdenum	10 / 10	100%	:	1.6 - 1.9	1.78	0.132	0.074	-0.643	Non-parametric	1.854908	Modified-t UCL	1.9	*	1.9	
Nickel	10 / 10	100%	:	2.8 - 5	3.23	0.65	0.201	2.682	Non-parametric	3.635771	Modified-t UCL	5	*	5	
Potassium	10 / 10	100%	:	6490 - 8190	6961	500	0.072	1.842	G/NP	7256.222	Approximate Gamma UCL	8190		8190	
Sodium	10 / 10	100%	:	49500 - 60200	55570	36093	0.650	-0.549	Normal	57662.22	Student's-t UCL	121728	66077	60200	163849
Thallium	1 / 10	10%	0.013 : 0.032	0.45 - 0.45	0.052	0.14	2.692		Poisson				0.105	0.45	
Uranium	10 / 10	100%	:	0.004 - 0.097	0.02065	0.027851	1.349	2.737	G/NP	0.042868	Approximate Gamma UCL	0.097	*	0.097	
Vanadium	1 / 10	10%	0.63 : 5.5	0.9 - 0.9	1.39	0.9	0.647		Poisson				4.5	0.9	
Zinc	10 / 10	100%	:	7.5 - 17.1	9.53	2.87	0.301	2.411	G/NP	11.20188	Approximate Gamma UCL	17.1	*	17.1	
Zirconium	1 / 10	10%	0.054 : 0.37	0.96 - 0.96	0.18	0.28	1.556		Poisson				0.6	0.96	
Dissolved Metals (UG/L)															
Aluminum	10 / 10	100%	:	4.7 - 21.6	10.68	6.01	0.563	0.757	Normal	14.16632	Student's-t UCL	21.7	28.2	21.6	28.7
Arsenic	7 / 10	70%	0.96 : 0.96	0.96 - 1.6	1.1	0.47	0.427	-0.538	G/NP	1.490713	Approximate Gamma UCL	1.6	*	1.60	
Barium	10 / 10	100%	:	16.2 - 17.7	16.94	0.5	0.030	0.028	Normal	17.22816	Student's-t UCL	17.9	18.4	17.7	18.4
Calcium	10 / 10	100%	:	18100 - 19900	18870	614.7	0.033	0.275	Normal	19226.35	Student's-t UCL	19997	20660	19900	20714.1
Copper	10 / 10	100%	:	2.2 - 2.6	2.34	0.135	0.058	0.772	Normal	2.418251	Student's-t UCL	2.59	2.73	2.60	2.75
Iron	10 / 10	100%	:	208 - 327	253.3	42.9	0.169	0.639	Non-parametric	278.6115	Modified-t UCL	327	*	327	
Lead	10 / 10	100%	:	0.21 - 0.49	0.345	0.097	0.281	0.007	Normal	0.401152	Student's-t UCL	0.52	0.63	0.49	0.636
Magnesium	10 / 10	100%	:	3950 - 4290	4049	104.2	0.026	1.463	Normal	4109.394	Student's-t UCL	4240	4352	4290	4361.6
Manganese	10 / 10	100%	:	46.1 - 59.4	50.35	4.67	0.093	1.151	Non-parametric	53.14673	Modified-t UCL	59.4	*	59.4	
Mercury	1 / 10	10%	0.037 : 0.037	0.21 - 0.21	0.038	0.061	1.605		Poisson				0.085	0.21	
Molybdenum	10 / 10	100%	:	1.6 - 2.1	1.83	0.183	0.100	-0.144	Normal	1.936011	Student's-t UCL	2.17	2.36	2.1	2.379
Nickel	10 / 10	100%	:	2.9 - 4.7	3.23	0.53	0.164	2.972	Non-parametric	3.560365	Modified-t UCL	4.7	*	4.7	
Potassium	10 / 10	100%	:	6400 - 7310	6886	332.7	0.048	-0.121	Normal	7078.844	Student's-t UCL	7496	7854	7310	
Selenium	4 / 10	40%	1.5 : 3.3	1.5 - 2.7	1.53	0.59	0.386	0.531	Normal	1.869717	Student's-t UCL		*	2.7	
Sodium	10 / 10	100%	:	56300 - 64400	5890	2513.7	0.427	1.563	G/NP	60177.1	Approximate Gamma UCL	64400	*	64400	
Thallium	1 / 10	10%	0.013 : 0.04	0.39 - 0.39	0.047	0.12	2.553		Poisson				0.105	0.39	
Uranium	6 / 10	60%	0.003 : 0.003	0.026 - 0.036	0.0103	0.007711	0.749	-0.365	Non-parametric	0.020929	95% Chebyshev (Mean, Sd) UCL	0.036	*	0.036	
Zinc	4 / 10	40%	6 : 9	10.4 - 14	7.12	4.5	0.632	0.586402	Non-parametric	13.32284	95% Chebyshev (Mean, Sd) UCL	14	*	14	
Zirconium	1 / 10	10%	0.072 : 1.1	1.1 - 1.1	0.25	0.34	1.360		Poisson				0.75	1.10	

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833.

4. The factor for a one-sided 95% coverage, 95% tolerance limit on 10 samples is 2.911.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

8. Shaded cell highlights an ordered value that is a 1/2DL value.

Table 4
Summary Statistics
Assabet River Surface Water, Downstream

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD
VOCs (UG/L)															
Methyl ethyl ketone	5 / 5	100%	:	0.0023 - 0.011	0.00544	0.00346	0.636	1.228	Normal	0.009	Student's-t UCL	0.013	0.020	0.011	0.016
Methyl Tertbutyl Ether	3 / 5	60%	0.0005 : 0.0005	0.00025 - 0.00027	0.000258	0.000011	0.043	0.609	Non-parametric	0.00027	Modified-t UCL	0.00027	*	0.00027	
Total Metals (UG/L)															
Aluminum	5 / 5	100%	:	42.3 - 180	86.2	55.3	0.642	1.719	Normal	138.897	Student's-t UCL	204.1	318.4	180.0	252.1
Arsenic	4 / 5	80%	0.96 : 0.96	0.97 - 2.3	1.25	0.69	0.552	0.865	Normal	1.907	Student's-t UCL	2.72	4.14	2.30	3.32
Barium	5 / 5	100%	:	16.8 - 20.7	17.92	1.61	0.090	1.906	G/NP	19.662	Approximate Gamma UCL	20.7	*	20.7	
Cadmium	2 / 5	40%	0.013 : 0.013	0.017 - 0.022	0.012	0.0073	0.608	0.865	Normal	0.019	Student's-t UCL	0.022	*	0.022	
Calcium	5 / 5	100%	:	20200 - 21000	20600	374.2	0.018	-0.382	Normal	20956.730	Student's-t UCL	21398	22172	21000	21723
Cobalt	5 / 5	100%	:	0.41 - 0.81	0.528	0.166	0.314	1.758	Normal	0.686	Student's-t UCL	0.88	1.22	0.81	1.03
Copper	5 / 5	100%	:	3.3 - 7.1	4.44	1.57	0.354	1.710	Normal	5.939	Student's-t UCL	7.79	11.05	7.10	9.15
Iron	5 / 5	100%	:	482 - 975	630.8	203.9	0.323	1.705	Normal	825.202	Student's-t UCL	1066	1488	975	1243
Lead	5 / 5	100%	:	1.2 - 4.8	2.16	1.52	0.704	1.960	G/NP	4.444	Approximate Gamma UCL	4.8	*	4.8	
Magnesium	5 / 5	100%	:	4780 - 5160	5020	159.4	0.032	-0.993	Normal	5171.945	Student's-t UCL	5360	5690	5160	5498
Manganese	5 / 5	100%	:	62.6 - 151	91.44	36	0.394	1.555	Normal	125.730	Student's-t UCL	168.2	242.6	151	199.4
Molybdenum	5 / 5	100%	:	1.8 - 2	1.94	0.089	0.046	-1.258	Normal	2.025	Student's-t UCL	2.13	2.31	2.00	2.21
Nickel	5 / 5	100%	:	3.7 - 4.2	3.88	0.19	0.049	1.517	Normal	4.063	Student's-t UCL	4.29	4.69	4.20	4.45
Potassium	5 / 5	100%	:	7430 - 7980	7590	224.6	0.030	1.921	Lognormal	7818.522	Modified-t UCL			7980	
Potassium (log-transform)					8.934	0.0291						8071	8572	7980	8278
Selenium	1 / 5	20%	1.5 : 1.5	1.7 - 1.7	0.94	0.42	0.447	2.236	Non-parametric	1.377	Modified-t UCL	1.7	*	1.7	
Sodium	5 / 5	100%	:	60800 - 66500	64560	2296	0.036	-1.463	Normal	66749.270	Student's-t UCL	69455	74209	66500	71448
Titanium	1 / 5	20%	7 : 7	8.2 - 8.2	4.44	2.1	0.473	2.236	Non-parametric	6.601	Modified-t UCL	8.2	*	8.2	
Uranium	5 / 5	100%	:	0.037 - 0.067	0.0296	0.020968	0.708	2.204	Non-parametric	0.070	95% Chebyshev (Mean, Sd) UCL	0.074	0.097	0.067	0.093
Zinc	5 / 5	100%	:	7.3 - 12.3	9.24	1.9	0.206	1.208	Normal	11.051	Student's-t UCL	13.29	17.22	12.30	14.94
Dissolved Metals (UG/L)															
Aluminum	5 / 5	100%	:	12.6 - 15.1	14.06	1.17	0.083	-0.564	Normal	15.179	Student's-t UCL	16.55	18.99	15.10	17.57
Arsenic	4 / 5	80%	0.96 : 0.96	0.98 - 2.2	1.31	0.71	0.542	0.299	Normal	1.992	Student's-t UCL	2.82	4.31	2.20	3.44
Barium	5 / 5	100%	:	17.2 - 17.8	17.48	0.3	0.017	0.315	Normal	17.769	Student's-t UCL	18.12	18.75	17.80	18.38
Calcium	5 / 5	100%	:	19900 - 21400	20440	568.3	0.028	1.613	Normal	20981.840	Student's-t UCL	21652	22828	21400	22145
Cobalt	5 / 5	100%	:	0.38 - 0.49	0.426	0.051	0.120	0.459	Normal	0.475	Student's-t UCL	0.53	0.64	0.49	0.58
Copper	5 / 5	100%	:	2.3 - 2.9	2.54	0.23	0.091	1.033	Normal	2.759	Student's-t UCL	3.03	3.51	2.90	3.23
Iron	5 / 5	100%	:	171 - 392	271.4	82.1	0.303	0.532	Normal	349.655	Student's-t UCL	446.4	616.3	392.0	517.7
Lead	5 / 5	100%	:	0.23 - 0.44	0.35	0.094	0.269	-0.553	Normal	0.440	Student's-t UCL	0.55	0.74	0.44	0.63
Magnesium	5 / 5	100%	:	4470 - 4660	4550	74.2	0.016	0.735	Normal	4620.705	Student's-t UCL	4708	4862	4660	4773
Manganese	5 / 5	100%	:	55.5 - 106	76.74	21.14	0.275	0.689	Normal	96.895	Student's-t UCL	121.8	165.6	106.0	140.2
Molybdenum	5 / 5	100%	:	2 - 2.1	2.02	0.045	0.022	2.236	Non-parametric	2.066	Modified-t UCL	2.1	*	2.1	
Nickel	5 / 5	100%	:	3.7 - 3.9	3.78	0.084	0.022	0.512	Normal	3.860	Student's-t UCL	3.96	4.13	3.90	4.03
Potassium	5 / 5	100%	:	7570 - 8340	7942	339.7	0.043	-0.017	Normal	8265.830	Student's-t UCL	8666	9369	8340	8961
Selenium	4 / 5	80%	1.5 : 1.5	2.3 - 2.6	2.07	0.75	0.362	-2.082	Non-parametric	3.528	95% Chebyshev (Mean, Sd) UCL	2.6	*	2.6	
Sodium	5 / 5	100%	:	67300 - 73100	70400	2218	0.032	-0.309	Normal	72514.720	Student's-t UCL	75129	79720	73100	77054
Uranium	5 / 5	100%	:	0.027 - 0.035	0.015	0.001541	0.103	1.281	Normal	0.016	Student's-t UCL	0.018	0.043	0.035	0.020
Zinc	2 / 5	40%	7.9 : 9.5	10.8 - 11	6.92	3.65	0.527	0.580009	G/NP	12.734	Approximate Gamma UCL	11	*	11	
Zirconium	1 / 5	20%	0.15 : 0.51	1.4 - 1.4	0.404	0.56	1.386	2.163493	G/NP	1.670	Approximate Gamma UCL	1.4	*	1.4	

Notes: 1. For 5 samples, the non-parametric 95th percentile is the 5th ordered sample, i.e., the same as the maximum.
    2. For 5 samples, the non-parametric one-sided 95% UCL on the mean is the 4th ordered sample.
    3. The Student-t value for 5-1 = 4 degrees of freedom and 95% level of confidence is 2.132.
    4. The factor for a one-sided 95% coverage, 95% tolerance limit is 4.202.
    5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.
    6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.
    7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 5
Summary Statistics
Assabet River Sediments, Upstream

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
VOCs (UG/KG)																
1,1,1-Trichloroethane	2 / 10	20%	0.894 : 1.43	6.5 - 28.8	3.96	8.93	2.255	2.932328	Non-parametric	21.58997	97.5% Chebyshev (Mean, Sd) UCL	28.8	*	28.8		28.8
1,1-Dichloroethane	1 / 10	10%	0.894 : 1.43	2.1 - 2.1	0.71	0.50	0.711		Poisson					3	2.10	2.1
1,1-Dichloroethene	1 / 10	10%	0.894 : 5.2	23.4 - 23.4	3.12	7.16	2.292		Poisson					7.5	23.4	7.5
Carbon disulfide	1 / 10	10%	4.47 : 7.17	3.2 - 3.2	2.80	0.56	0.200		Poisson					7	3.20	3.2
Cis-1,2-Dichloroethene	1 / 10	10%	0.894 : 1.43	0.89 - 0.89	0.58	0.15	0.260		Poisson					3	0.89	0.89
Tetrachloroethene	2 / 10	20%	0.894 : 1.43	3.8 - 5.2	1.33	1.71	1.283	1.925618	Non-parametric	3.681321	95% Chebyshev (Mean, Sd) UCL	5.2	*	5.20		5.2
Trichloroethene	4 / 10	40%	0.894 : 1.43	0.9 - 46.4	7.08	14.93	2.108	2.514369	Non-parametric	36.56896	97.5% Chebyshev (Mean, Sd) UCL	46.4	*	46.4		46.4
Trichlorofluoromethane	1 / 10	10%	0.894 : 1.43	3.6 - 3.6	0.87	0.96	1.102		Poisson					3.5	3.60	3.5
Metals (MG/KG)																
Aluminum	10 / 10	100%	:	2650 - 16700	7862	4960	0.631	0.955	Normal	10736.98	Student's-t UCL	16954	22299	16700	22742	16700
Arsenic	10 / 10	100%	:	2.7 - 109	24.76	39.9	1.611	1.801	Non-parametric	103.5272	97.5% Chebyshev (Mean, Sd) UCL	109	*	109		109
Barium	10 / 10	100%	:	17.4 - 82.3	41.26	21.71	0.526	0.853	Normal	53.84492	Student's-t UCL	81.1	104.5	82.3	106.4	81.1
Beryllium	10 / 10	100%	:	0.097 - 50.8	5.35	15.97	2.983	3.161	Non-parametric	36.8909	97.5% Chebyshev (Mean, Sd) UCL	50.8	*	50.8		50.8
Cadmium	10 / 10	100%	:	0.12 - 2.5	0.507	0.72	1.420	2.859	G/NP	0.987812	Approximate Gamma UCL	2.5	*	2.50		2.5
Calcium	10 / 10	100%	:	655 - 6380	2147.4	1998.2	0.931	1.463	G/NP	3709.501	Approximate Gamma UCL	6380	*	6380		6380
Chromium	10 / 10	100%	:	11.3 - 40.6	23.7	9.59	0.405	0.721	Normal	29.26038	Student's-t UCL	41.3	51.6	40.6	52.5	40.6
Cobalt	10 / 10	100%	:	2.2 - 30.6	9.3	9.89	1.063	1.713	G/NP	16.89027	Approximate Gamma UCL	30.6		30.6		30.6
Copper	10 / 10	100%	:	9.1 - 46.7	25.02	12.58	0.503	0.308	Normal	32.31323	Student's-t UCL	48.1	61.6	46.7	62.8	46.7
Iron	10 / 10	100%	:	5620 - 64200	19607	17912	0.914	1.988	G/NP	32754.63	Approximate Gamma UCL	64200	*	64200		64200
Lead	10 / 10	100%	:	8.2 - 88.1	30.77	24.6	0.799	1.576	G/NP	49.47006	Approximate Gamma UCL	88.1	*	88.1		88.1
Magnesium	10 / 10	100%	:	932 - 7610	2969.4	1867.1	0.629	1.760	G/NP	4351.065	Approximate Gamma UCL	7610	*	7610		7610
Manganese	10 / 10	100%	:	69 - 3010	489.1	892	1.824	3.081	Lognormal	969.4473	95% Chebyshev (MVUE) UCL			3010		
Mananese (Log transform)	10 / 10	100%	:		5.481	1.0466						1635	5053	3010	5546	1635
Mercury	10 / 10	100%	:	0.0066 - 0.13	0.0597	0.041	0.687	0.456	Normal	0.083419	Student's-t UCL	0.13	0.18	0.13	0.18	0.13
Molybdenum	10 / 10	100%	:	0.35 - 6.1	1.822	2.074	1.138	1.333	Non-parametric	5.917974	97.5% Chebyshev (Mean, Sd) UCL	6.1	*	6.1		6.1
Nickel	10 / 10	100%	:	4.3 - 29.8	15.85	8.42	0.531	0.544	Normal	20.73029	Student's-t UCL	31.3	40.4	29.8	41.1	29.8
Potassium	10 / 10	100%	:	315 - 4960	1490.5	1549.4	1.040	1.705	G/NP	2720.932	Approximate Gamma UCL	4960	*	4960		4960
Silver	10 / 10	100%	:	0.033 - 0.34	0.146	0.095	0.651	0.982	Normal	0.201594	Student's-t UCL	0.3	0.42	0.34	0.4	0.3
Sodium	10 / 10	100%	:	53.4 - 892	201.51	251.7	1.249	2.770	G/NP	366.1391	Approximate Gamma UCL	892	*	892		892
Thallium	10 / 10	100%	:	0.046 - 0.43	0.17	0.14	0.824	1.100	G/NP	0.275705	Approximate Gamma UCL	0.43	*	0.43		0.43
Thorium	10 / 10	100%	:	2.3 - 13.8	5.40	3.41	0.631	1.871	G/NP	7.704586	Approximate Gamma UCL	13.8	*	13.8		13.8
Titanium	10 / 10	100%	:	186 - 648	378	165.4	0.438	0.470	Normal	473.8617	Student's-t UCL	2013	859	648	874	648
Tungsten	9 / 10	90%	0.9 : 0.9	0.27 - 1.3	0.7	0.32	0.457	0.410	Normal	0.885216	Student's-t UCL	1.29	1.63	1.30	1.66	1.29
Uranium	10 / 10	100%	:	0.62 - 6.1	1.797	1.578	0.878	2.700	Lognormal	2.879782	95% H-UCL			6.1		
Uranium (log-transform)	10 / 10	100%			0.375	0.617	1.645					4.5	8.8	6.1	9.3	4.5
Uranium (no 17004)	9 / 9	100%		0.62 - 2.2	1.32	0.481	0.364		Normal	1.617101	Student's-t UCL	2.21	2.78	2.20	2.76	2.2
Vanadium	10 / 10	100%	:	7.3 - 53.9	19.54	15.14	0.775	1.750	G/NP	30.03314	Approximate Gamma UCL	53.9	*	53.9		53.9
Zinc	10 / 10	100%	:	17.8 - 55.6	41.79	11.41	0.273	-0.940	Normal	48.40257	Student's-t UCL	63.01	75	55.6	76.02	55.6
Zirconium	9 / 10	90%	0.9 : 0.9	0.75 - 3.4	2.15	0.988	0.460	-0.503	Normal	2.722878	Student's-t UCL	3.96	5.03	3.40	5.11	3.4

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833, for 8 df is 1.860.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911, and for 9 samples 3.023.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 6
Summary Statistics
Assabet River Sediments, Site

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD
VOCs (UG/KG)																	
1,1,1-Trichloroethane	4 / 10	40%	0.799 :	1.09	1.4 -	8.4	1.59	2.44	1.535	2.925492	Non-Parametric	4.959341	95% Chebyshev (Mean, Std) UCL	8.4	*	8.4	
1,1-Dichloroethane	1 / 10	10%	0.799 :	1.26	0.47 -	0.47	0.499	0.0687	0.138		Poisson					1.05	0.47
1,1-Dichloroethene	1 / 10	10%	0.799 :	1.3	2 -	2	0.652	0.48	0.736		Poisson					1.25	2
Tetrachloroethene	7 / 10	70%	0.923 :	1	0.44 -	9.5	2.79	3.83	1.373	1.276	Non-Parametric	8.069398	95% Chebyshev (Mean, Std) UCL	9.5	*	9.5	
Trichloroethene	6 / 10	60%	0.799 :	1	2.3 -	20.7	3.68	6.11	1.660	2.916	G/NP	8.516712	Approximate Gamma UCL	20.7	*	20.7	
Metals (MG/KG)																	
Aluminum	10 / 10	100%	:		3310 -	10000	6382	2205	0.346	0.473	Normal	7660.164	Student's-t UCL	10424	12801	10000	12997
Arsenic	10 / 10	100%	:		2.5 -	22	7.43	6.01	0.809	1.795	G/NP	11.82328	Approximate Gamma UCL	22	*	22	
Barium	10 / 10	100%	:		12.6 -	45.4	26.42	9.65	0.365	0.710	Normal	32.01637	Student's-t UCL	44.1	54.5	45.4	55.4
Beryllium	10 / 10	100%	:		0.15 -	0.42	0.259	0.08	0.309	0.754	Normal	0.305571	Student's-t UCL	0.41	0.49	0.42	0.50
Cadmium	10 / 10	100%	:		0.054 -	0.47	0.153	0.121	0.791	2.329	G/NP	0.232071	Approximate Gamma UCL	0.47	*	0.47	
Calcium	10 / 10	100%	:		550 -	3420	1256.9	809.7	0.644	2.500	G/NP	1751.516	Approximate Gamma UCL	3420	*	3420	
Chromium	10 / 10	100%	:		13.4 -	58.5	30.93	15.61	0.505	1.029	Normal	39.97864	Student's-t UCL	59.5	76.4	58.5	77.8
Cobalt	10 / 10	100%	:		2.2 -	12.3	5.55	2.92	0.526	1.524	Normal	7.243192	Student's-t UCL	10.9	14.1	12.3	14.3
Copper	10 / 10	100%	:		4.7 -	22.5	12.28	5.54	0.451	0.615	Normal	15.4915	Student's-t UCL	22.4	28.4	22.5	28.9
Iron	10 / 10	100%	:		7200 -	16300	10923	2923	0.268	0.597	Normal	12617.23	Student's-t UCL	16281	19431	16300	19692
Lead	10 / 10	100%	:		5 -	251	41.64	74.47	1.788	3.024	Lognormal	84.56184	95% Chebyshev (MVUE) UCL			251	
Lead (log-transformed)	10 / 10	100%					3.009	1.069						144	455	251	501
Magnesium	10 / 10	100%	:		1340 -	3780	2597	850.6	0.328	0.263	Normal	3090.059	Student's-t UCL	4156	5073	3780	5149
Manganese	10 / 10	100%	:		90.8 -	400	208.3	103	0.494	0.810	Normal	267.9703	Student's-t UCL	397	508	400	517
Mercury	10 / 10	100%	:		0.0071 -	0.66	0.113	0.194	1.717	3.016	Lognormal	0.26768	95% Chebyshev (MVUE) UCL			0.66	
Mercury (log-transformed)	10 / 10	100%					-2.909	1.178						0.47	1.68	0.66	1.87
Molybdenum	10 / 10	100%	:		0.15 -	4.5	1.211	1.417	1.170	1.718	G/NP	2.463872	Approximate Gamma UCL	4.5	*	4.5	
Nickel	10 / 10	100%	:		8.3 -	20.7	13.35	4.36	0.327	0.626	Normal	15.87518	Student's-t UCL	21.3	26.0	20.7	26.4
Potassium	10 / 10	100%	:		256 -	1290	825.2	364.2	0.441	-0.429	Normal	1036.32	Student's-t UCL	1493	1885	1290	1918
Selenium	1 / 10	10%	0.355 :	1.3	0.95 -	0.95	0.456	0.226	0.496		Poisson					0.95	0.95
Silver	10 / 10	100%	:		0.022 -	0.3	0.104	0.081	0.779	1.703	Normal	0.151084	Student's-t UCL	0.25	0.34	0.30	0.35
Sodium	10 / 10	100%	:		68.6 -	151	110.2	24.73	0.224	0.100	Normal	124.5061	Student's-t UCL	156	182	151	184
Thallium	10 / 10	100%	:		0.055 -	0.16	0.093	0.034	0.366	0.781	Normal	0.11242	Student's-t UCL	0.16	0.19	0.16	0.20
Thorium	10 / 10	100%	:		2.2 -	6.1	3.58	1.09	0.304	1.326	Normal	4.212535	Student's-t UCL	5.58	6.76	6.10	6.85
Titanium	10 / 10	100%	:		188 -	545	355.7	112.4	0.316	0.159	Normal	420.8522	Student's-t UCL	562	683	545	693
Tungsten	9 / 10	90%	0.2 :	0.2	0.24 -	1.2	0.613	0.37	0.604	0.265	Normal	0.828291	Student's-t UCL	1.29	1.69	1.20	1.72
Uranium	10 / 10	100%	:		0.66 -	2.5	1.296	0.623	0.481	0.971	Normal	1.657083	Student's-t UCL	2.44	3.11	2.50	3.17
Vanadium	10 / 10	100%	:		10.1 -	22.5	15.02	3.9	0.260	0.729	Normal	17.28262	Student's-t UCL	22.2	26.4	22.5	26.7
Zinc	10 / 10	100%	:		14.3 -	52.7	34.34	13.15	0.383	-0.028	Normal	41.96168	Student's-t UCL	58.4	72.6	52.7	73.8
Zirconium	10 / 10	100%	:		0.87 -	2.4	1.573	0.472	0.300	0.209	Normal	1.84662	Student's-t UCL	2.44	2.95	2.40	2.99

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

    2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

    3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833, for 8 df is 1.860.

    4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911, and for 9 samples 3.023.

    5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

    6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

    7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 7
Summary Statistics
Assabet River Sediments, Downstream

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD
VOCs (UG/KG)																	
1,1-Dichloroethene	1 / 5	20%	0.976 :	2.17	0.8 -	0.8	0.787	0.213	0.271	-0.004338	Normal	0.989	Student's-t UCL	1.09	*	0.8	
Acetone	5 / 5	100%	:		5.9 -	214	87.5	89.1	1.018	2.148	Lognormal	5.124	95% H-UCL			214	
Acetone (log-transformed)							3.816	1.466	0.384					1034	21507	214	3692
Carbon disulfide	2 / 5	40%	4.88 :	10.8	4.1 -	7.8	4.69	2.03	0.433	0.886	Normal	6.630	Student's-t UCL	7.8	*	7.8	
Methyl ethyl ketone	3 / 5	60%	4.88 :	6.55	11.3 -	45.8	18.28	18.63	1.019	0.917	Normal	36.047	Student's-t UCL	58.0	96.6	45.8	74.2
Toluene	1 / 5	20%	0.976 :	2.17	0.77 -	0.77	0.75	0.22	0.293	0.785	Normal	0.957	Student's-t UCL	1.09	*	0.77	
Metals (MG/KG)																	
Aluminum	5 / 5	100%	:		3130 -	7390	5774	2139	0.370	-0.653	Non-parametric	7766.678	Modified-t UCL	7390	*	7390	
Antimony	3 / 5	60%	0.0509 :	0.082	0.17 -	0.22	0.133	0.093	0.699	-0.454	Normal	0.222	Student's-t UCL	0.3	0.52	0.22	0.4
Arsenic	5 / 5	100%	:		2.9 -	121	29.16	51.4	1.763	2.213	Lognormal	157.023	99% Chebyshev (MVUE) UCL			121	
Arsenic (log-transformed)	5 / 5	100%					2.288	1.518						251	5806	121	936
Barium	5 / 5	100%	:		19.1 -	73.9	41.28	22.03	0.534	0.834	Normal	62.288	Student's-t UCL	88.2	133.9	73.9	107.4
Beryllium	5 / 5	100%	:		0.14 -	0.6	0.326	0.176	0.540	0.964	Normal	0.494	Student's-t UCL	0.7	1.06	0.6	0.9
Cadmium	5 / 5	100%	:		0.11 -	1.1	0.436	0.417	0.956	1.321	Normal	0.833	Student's-t UCL	1.3	2.19	1.1	1.7
Calcium	5 / 5	100%	:		534 -	1760	1268.8	483	0.381	-0.846	Normal	1729.296	Student's-t UCL	2298.6	3298	1760	2717.8
Chromium	5 / 5	100%	:		17.1 -	469	135.8	194.1	1.429	1.848	G/NP	724.295	Approximate Gamma UCL	469	*	469	
Cobalt	5 / 5	100%	:		3.6 -	16.4	9.62	5.83	0.606	0.005	Normal	15.180	Student's-t UCL	22.0	34.1	16.4	27.1
Copper	5 / 5	100%	:		5.4 -	73.8	34.86	34.91	1.001	0.586	G/NP	133.483	Approximate Gamma UCL	73.8	*	73.8	
Iron	5 / 5	100%	:		4690 -	114000	29258	47465	1.622	2.214	Lognormal	77328.470	95% Chebyshev (MVUE) UCL			114000	
Iron (log-transformed)	5 / 5	100%					9.469	1.273						195445	2725455	114000	590072
Lead	5 / 5	100%	:		5.2 -	327	94.72	134.2	1.417	1.915	G/NP	517.088	Approximate Gamma UCL	327	*	327	
Magnesium	5 / 5	100%	:		1060 -	2640	1776	661.7	0.373	0.104	Normal	2406.846	Student's-t UCL	3186.7	4556	2640	3761.1
Manganese	5 / 5	100%	:		83.4 -	564	262.1	180	0.687	1.531	Normal	433.668	Student's-t UCL	645.9	1018	564	802.1
Mercury	5 / 5	100%	:		0.019 -	0.39	0.191	0.167	0.874	0.455	Normal	0.351	Student's-t UCL	0.5	0.89	0.39	0.7
Molybdenum	5 / 5	100%	:		0.56 -	8.4	2.61	3.29	1.261	2.081	G/NP	9.813	Approximate Gamma UCL	8.4	*	8.4	
Nickel	5 / 5	100%	:		6.1 -	26.7	13.24	8.39	0.634	1.240	Normal	21.238	Student's-t UCL	31.1	48.5	26.7	38.4
Potassium	5 / 5	100%	:		380 -	1040	654	265.8	0.406	0.575	Normal	907.418	Student's-t UCL	1220.7	1771	1040	1451.4
Selenium	5 / 5	100%	:		0.59 -	1.5	1.094	0.373	0.341	-0.338	Normal	1.450	Student's-t UCL	1.9	2.66	1.5	2.2
Silver	5 / 5	100%	:		0.057 -	0.57	0.269	0.249	0.926	0.612	Normal	0.507	Student's-t UCL	0.8	1.31	0.57	1.0
Sodium	5 / 5	100%	:		73 -	251	159.8	66.8	0.418	0.144	Normal	223.490	Student's-t UCL	302.2	440	251	360.2
Thallium	5 / 5	100%	:		0.05 -	0.18	0.126	0.058	0.460	-0.588	Normal	0.181	Student's-t UCL	0.2	0.37	0.18	0.3
Thorium	5 / 5	100%	:		1.4 -	4.5	2.94	1.3	0.442	-0.188	Normal	4.177	Student's-t UCL	5.7	8.4	4.5	6.8
Titanium	5 / 5	100%	:		190 -	438	297	101.3	0.341	0.359	Normal	393.542	Student's-t UCL	513.0	722	438	600.9
Tungsten	5 / 5	100%	:		0.59 -	1.9	1	0.533	0.533	1.678	Normal	1.506	Student's-t UCL	2.1	3.24	1.9	2.6
Uranium	5 / 5	100%	:		0.48 -	1.3	1	0.323	0.323	-1.266	Normal	1.306	Student's-t UCL	1.7	2.36	1.3	2.0
Vanadium	5 / 5	100%	:		7.6 -	50	21.76	17.43	0.801	1.345	Normal	38.382	Student's-t UCL	58.9	95	50	74.1
Zinc	5 / 5	100%	:		26.4 -	260	95.68	97.89	1.023	1.653	Normal	189.013	Student's-t UCL	304.4	507	260	389.4
Zirconium	5 / 5	100%	:		0.72 -	4	1.58	1.36	0.861	2.148	Lognormal	5.124	95% H-UCL			4	
Zirconium (log-transformed)	5 / 5	100%					0.246	0.663						5	21	4	9

Notes: 1. For 5 samples, the non-parametric 95th percentile is the 5th ordered sample, i.e., the same as the maximum.

2. For 5 samples, the non-parametric one-sided 95% UCL on the mean is the 4th ordered sample.

3. The Student-t value for 5-1 = 4 degrees of freedom and 95% level of confidence is 2.132.

4. The factor for a one-sided 95% coverage, 95% tolerance limit is 4.202.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

8. Shaded cell highlights an ordered value that is a 1/2DL value.

Table 8
Summary Statistics
Maynard Pond Surface Water, Metals

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Total Metals (UG/L)																		
Barium	5 / 5	100%	:		3.6 -	4	3.78	0.15	0.040	0.552	Normal	3.921411	Student's-t UCL	4.10	4.40	4.00	4.23	4
Calcium	5 / 5	100%	:		902 -	925	917.2	9.26	0.010	-1.485	Normal	926.0259	Student's-t UCL	937	956	925	945	925
Lead	5 / 5	100%	:		3.7 -	4.7	3.98	0.41	0.103	2.070	Non-parametric	4.397813	Modified-t UCL	4.70	*	4.70		4.7
Magnesium	5 / 5	100%	:		186 -	216	206	12.41	0.060	-1.381	Normal	217.8313	Student's-t UCL	232	258	216	243	216
Mercury	1 / 5	20%	0.037 :	0.037	0.04 -	0.04	0.0228	0.0096	0.421	2.236	Non-parametric	0.032684	Modified-t UCL	0.04	*	0.04		0.04
Potassium	5 / 5	100%	:		1320 -	1420	1364	35.78	0.026	0.821	Normal	1398.11	Student's-t UCL	1440	1514	1420	1471	1420
Sodium	5 / 5	100%	:		2640 -	2900	2766	121.16	0.044	0.370	Normal	2881.514	Student's-t UCL	3024	3275	2900	3129	2900
Zinc	5 / 5	100%	:		26 -	27.9	26.64	0.75	0.028	1.617	Normal	27.35536	Student's-t UCL	28.2	29.8	27.9	28.9	27.9
Dissolved Metals (UG/L)																		
Arsenic	3 / 5	60%	0.96 :	0.96	1.5 -	1.5	1.092	0.56	0.513	-0.609	Non-parametric	2.181062	95% Chebyshev (Mean, Sd) UCL	1.50	*	1.50		1.5
Barium	3 / 5	100%	:		3.2 -	3.4	3.28	0.083	0.025	0.512	Normal	3.359766	Student's-t UCL	3.46	3.63	3.40	3.53	3.4
Chromium	3 / 5	60%	0.14 :	0.14	0.18 -	0.51	0.24	0.19	0.792	0.713	Normal	0.421809	Student's-t UCL	0.65	1.05	0.51	0.81	0.51
Lead	4 / 5	80%	2 :	2	2.2 -	2.3	2	0.56	0.280	-2.192	Non-parametric	2.494084	Modified-t UCL	2.30	*	2.30		2.3
Magnesium	3 / 5	60%	152 :	154	165 -	178	133	51.8	0.389	-0.571	Non-parametric	181.3937	Modified-t UCL	178	*	178		178
Manganese	5 / 5	100%	:		17.2 -	18	17.56	0.32	0.018	0.299	Normal	17.86598	Student's-t UCL	18.2	18.9	18.0	18.5	18
Potassium	5 / 5	100%	:		1240 -	1290	1262	17.89	0.014	0.821	Normal	1279.055	Student's-t UCL	1300	1337	1290	1316	1290
Sodium	5 / 5	100%	:		2740 -	3020	2862	100.6	0.035	0.866	Normal	2957.909	Student's-t UCL	3076	3285	3020	3164	3076
Vanadium	1 / 5	20%	0.63 :	0.63	0.86 -	0.86	0.424	0.244	0.575	2.236068	Non-parametric	0.674538	Modified-t UCL	0.86	*	0.86		0.86

Notes: 1. For 5 samples, the non-parametric 95th percentile is the 5th ordered sample, i.e., the same as the maximum.

2. For 5 samples, the non-parametric one-sided 95% UCL on the mean is the 4th ordered sample.

3. The Student-t value for 5-1 = 4 degrees of freedom and 95% level of confidence is 2.132.

4. The factor for a one-sided 95% coverage, 95% tolerance limit is 4.202.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 9
Summary Statistics
Maynard Pond Sediments by 8270C

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
SVOCs (UG/KG)																
Acenaphthene	6 / 10	60%	44 : 176	13.2 - 242	73.74	73.44	0.996	1.675	G/NP	133.404	Approximate Gamma UCL	242	*	242		242
Acenaphthylene	4 / 10	40%	44 : 536	38.2 - 94.7	76.42	73.21	0.958	2.313	G/NP	128.1845	Approximate Gamma UCL	268	*	94.7		94.7
Anthracene	8 / 10	80%	44 : 54.8	33 - 340	123.7	109.3	0.884	1.202	G/NP	220.9936	Approximate Gamma UCL	340	*	340		340
Benzo[a]anthracene	8 / 10	80%	44 : 54.8	327 - 4340	981.3	1259.2	1.283	2.465	G/NP	2311.875	Approximate Gamma UCL	4340	*	4340		4340
Benzo[a]pyrene	10 / 10	100%	:	90.5 - 5550	1439.9	1614.3	1.121	2.097	G/NP	2990.497	Approximate Gamma UCL	5550	*	5550		5550
Benzo[b]fluoranthene	10 / 10	100%	:	60.1 - 9000	1644.1	2668.8	1.623	2.816	G/NP	3967.048	Approximate Gamma UCL	9000	*	9000		9000
Benzo[ghi]perylene	10 / 10	100%	:	32.3 - 2820	722	824.2	1.142	2.106	G/NP	1531.85	Approximate Gamma UCL	2820	*	2820		2820
Benzo[k]fluoranthene	9 / 10	90%	183 : 183	30.1 - 4100	716.4	1246.7	1.740	2.689	G/NP	1855.379	Approximate Gamma UCL	4100	*	4100		4100
Benzoic Acid	1 / 10	10%	885 : 10700	638 - 638	1398.4	1517.6	1.085		Poisson				2300	638		638
Bis(2-Ethylhexyl)phthalate	7 / 10	70%	274 : 935	41.5 - 627	289.79	234	0.807	0.168	Non-parametric	612.3329	95% Chebyshev (Mean, Sd) UCL	627	*	627		627
Chrysene	10 / 10	100%	:	40.4 - 5770	1394.6	1688.5	1.211	2.229	G/NP	3160.977	Approximate Gamma UCL	5770	*	5770		5770
Dibenz[a,h]anthracene	2 / 10	20%	44 : 536	54.2 - 163	79.1	80.3	1.015	1.749	G/NP	142.7788	Approximate Gamma UCL	268	*	163		163
Dibenzofuran	1 / 10	10%	440 : 5360	133 - 133	675.5	776	1.149		Poisson				1300	133		133
Fluoranthene	10 / 10	100%	:	94.9 - 9660	2650	2905.4	1.096	1.742	G/NP	5855.014	Approximate Gamma UCL	9660	*	9660		3660
Fluorene	8 / 10	80%	11.9 : 44	26 - 365	102.1	125	1.224	1.635	G/NP	217.577	Approximate Gamma UCL	365	*	365		365
Indeno[1,2,3-cd]pyrene	10 / 10	100%	:	48.3 - 2820	760.6	823.3	1.082	1.985	G/NP	1535.9	Approximate Gamma UCL	2820	*	2820		2820
Phenanthrene	10 / 10	100%	:	24.4 - 1820	661.7	577.7	0.873	0.889	Normal	996.5593	Student's-t UCL	1721	2343	1820	2395	1721
Pyrene	10 / 10	100%	:	64.3 - 9790	2269.8	2867.9	1.264	2.329	G/NP	5250.044	Approximate Gamma UCL	9790	*	9790		3790

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

8. Shaded cell highlights an ordered value that is a 1/2DL value.

Table 10
Summary Statistics
Maynard Pond Sediments by 8310

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
SVOCs (UG/KG)																
Anthracene	8 / 10	80%	87.9 : 110	74.6 - 442	215.7	145.3	0.674	0.288	Normal	299.91	Student's-t UCL	482	639	442	652	442
Benzo[a]anthracene	10 / 10	100%	:	41.5 - 2840	1235.6	949.3	0.768	0.344	Normal	1785.841	Student's-t UCL	2976	3999	2840	4084	2840
Benzo[a]pyrene	10 / 10	100%	:	46.2 - 2620	1174.1	919.1	0.783	0.379	Normal	1706.892	Student's-t UCL	2859	3849	2620	3931	2620
Benzo[b]fluoranthene	10 / 10	100%	:	49.6 - 3130	1239.7	978.6	0.789	0.566	Normal	1806.996	Student's-t UCL	3033	4088	3130	4176	3033
Benzo[ghi]perylene	7 / 10	70%	8.79 : 11	511 - 1460	661.2	555.7	0.840	0.150	Normal	983.3543	Student's-t UCL	1680	2279	1460	2328	1460
Benzo[k]fluoranthene	10 / 10	100%	:	28.7 - 1590	683.1	510.7	0.748	0.247	Normal	979.1617	Student's-t UCL	1619	2170	1590	2215	1590
Chrysene	10 / 10	100%	:	32 - 1810	850.2	676.1	0.795	0.243	Normal	1242.157	Student's-t UCL	2089	2818	1810	2879	1810
Fluoranthene	10 / 10	100%	:	75 - 5240	2254	1741	0.772	0.279	Normal	3263.233	Student's-t UCL	5445	7322	5240	7477	5240
Fluorene	1 / 10	10%	87.9 : 268	329 - 329	91.3	89.8	0.984		Poisson				165	329		165
Phenanthrene	10 / 10	100%	:	21.6 - 2060	909.9	687.9	0.756	0.200	Normal	1308.624	Student's-t UCL	2171	2912	2060	2974	2060
Pyrene	9 / 10	90%	11 : 11	79.4 - 4500	2001	1546	0.773	0.193	Normal	2897.626	Student's-t UCL	4835	6502	4500	6639	4500

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 11
Summary Statistics
Maynard Pond Sediments, Metals

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Metals (MG/KG)																		
Aluminum	10 / 10	100%		:	7430	- 23200	12712	4526.9	0.356	1.482	Normal	15336.16	Student's-t UCL	21010	25890	23200	26293	21010
Antimony	1 / 10	10%	0.15 : 0.47		0.66	- 0.66	0.18	0.175	0.972		Poisson				0.28	0.66		0.28
Arsenic	10 / 10	100%		:	3.7	- 11.8	6.72	3.12	0.464	0.901	G/NP	8.867257	Approximate Gamma UCL	11.8	*	11.8		11.8
Barium	10 / 10	100%		:	25.8	- 54.7	40.57	9.8	0.242	-0.206	Normal	46.2543	Student's-t UCL	58.5	69.1	54.7	70.0	54.7
Beryllium	10 / 10	100%		:	0.24	- 0.63	0.4	0.125	0.313	0.486	Normal	0.474649	Student's-t UCL	0.63	0.77	0.63	0.78	0.63
Cadmium	10 / 10	100%		:	0.16	- 2.9	0.72	0.82	1.139	2.529	G/NP	1.289241	Approximate Gamma UCL	2.9	*	2.90		2.9
Calcium	10 / 10	100%		:	638	- 1400	976.7	233.1	0.239	0.244	Normal	1111.804	Student's-t UCL	1404	1655	1400	1676	1400
Chromium	10 / 10	100%		:	13.7	- 37.5	25.22	7.59	0.301	-0.292	Normal	29.62056	Student's-t UCL	39.1	47.3	37.5	48.0	37.5
Cobalt	10 / 10	100%		:	1.8	- 5.7	3.84	1.33	0.346	-0.123	Normal	4.612522	Student's-t UCL	6.28	7.72	5.70	7.83	5.7
Copper	3 / 10	30%	16.7 : 29.1		16.9	- 30.8	14.14	6.64	0.470	1.962	G/NP	18.32449	Approximate Gamma UCL	30.8	*	30.8		30.8
Iron	10 / 10	100%		:	6610	- 18200	12292	3814.1	0.310	-0.154	Normal	14502.95	Student's-t UCL	19283	23395	18200	23734	18200
Lead	10 / 10	100%		:	24.8	- 242	136.5	76.4	0.560	-0.064	Normal	180.85	Student's-t UCL	277	359	242	366	242
Magnesium	10 / 10	100%		:	1230	- 3890	2839	828.4	0.292	-0.964	Normal	3319.226	Student's-t UCL	4357	5251	3890	5324	3890
Manganese	10 / 10	100%		:	57	- 121	95.44	23.11	0.242	-0.853	Normal	108.8349	Student's-t UCL	138	163	121	165	121
Mercury	10 / 10	100%		:	0.0074	- 0.35	0.101	0.105	1.040	1.863	G/NP	0.189551	Approximate Gamma UCL	0.35	*	0.35		0.35
Molybdenum	9 / 10	90%	0.56 : 0.56		0.56	- 1.3	0.855	0.363	0.425	0.048	Normal	1.065347	Student's-t UCL	1.52	1.91	1.30	1.94	1.3
Nickel	10 / 10	100%		:	7.4	- 21.1	13.64	4.24	0.311	0.209	Normal	16.09531	Student's-t UCL	21.4	26.0	21.1	26.4	21.1
Potassium	9 / 10	90%	657 : 657		1110	- 2330	1475.8	534.8	0.362	-0.773	Normal	1785.85	Student's-t UCL	2456	3033	2330	3080	2330
Silver	3 / 10	30%	0.035 : 0.089		0.027	- 0.17	0.045	0.045	1.000	2.939	Non-parametric	0.106871	95% Chebyshev (Mean, Std) UCL	0.17	*	0.17		0.17
Sodium	10 / 10	100%		:	57.2	- 393	172.7	123.6	0.716	1.175	G/NP	266.2052	Approximate Gamma UCL	393	*	393		393
Thallium	3 / 10	30%	0.12 : 0.2		0.091	- 0.23	0.099	0.048	0.485	2.660	G/NP	0.126582	Approximate Gamma UCL	0.23	*	0.23		0.23
Thorium	10 / 10	100%		:	0.85	- 5.7	4.39	1.42	0.323	-1.936	Non-parametric	6.347186	95% Chebyshev (Mean, Std) UCL	5.7	*	5.70		5.7
Titanium	10 / 10	100%		:	286	- 647	507.1	112	0.221	-0.914	Normal	572.0274	Student's-t UCL	712	833	647	843	647
Tungsten	9 / 10	90%	0.21 : 0.21		0.25	- 0.92	0.442	0.296	0.670	0.827	G/NP	0.6781	Approximate Gamma UCL	0.92	*	0.92		0.92
Uranium	10 / 10	100%		:	1	- 2.5	1.63	0.519	0.318	0.365	Normal	1.930653	Student's-t UCL	2.58	3.14	2.50	3.19	2.5
Vanadium	10 / 10	100%		:	13.4	- 35.2	25.99	7.28	0.280	-0.681	Normal	30.20753	Student's-t UCL	39.3	47.2	35.2	47.8	35.2
Zinc	3 / 10	30%	55.7 : 300		79.4	- 244	87.82	65.34	0.744	1.770	G/NP	134.5438	Approximate Gamma UCL	300	*	244		244
Zirconium	7 / 10	70%	0.46 : 1.2		1.1	- 2	1.295	0.657	0.507	-0.683	Normal	1.676057	Student's-t UCL	2.50	3.21	2.00	3.27	2

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 12
Summary Statistics
Forest Soils by 8270C

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
SVOCs (UG/KG)																
Benzo[a]anthracene	2 / 14	14%	35.9 : 42.9	31.1 - 33.2	21.51	4.61	0.214	2.152	Non-parametric	23.81625	Modified-t UCL	33.2	*	33.2		33.2
Benzo[a]pyrene	3 / 14	21%	37.7 : 42.9	28 - 220	36	53.2	1.478	3.689	Non-parametric	97.95316	95% Chebyshev (Mean, Sd) UCL	220	*	220		220
Benzo[b]fluoranthene	3 / 14	21%	37.7 : 42.9	51.6 - 66.2	28.46	17.2	0.604	1.670	Non-parametric	36.93806	Modified-t UCL	66.2	*	66.2		66.2
Benzoic Acid	11 / 14	79%	719 : 790	41.8 - 298	168.6	133.7	0.793	0.864	G/NP	252.9806	Approximate Gamma UCL			298		298
Benzoic Acid (log-trans)					4.825	0.816						524	1011	298	1441	298
Bis(2-Chloroethyl)ether	4 / 15	27%	359 : 430	324 - 3460	606.1	1000.2	1.650	2.494	Non-parametric	1731.784	95% Chebyshev (Mean, Sd) UCL	3460	*	3460		3460
Chrysene	7 / 14	50%	38.3 : 42.9	24.8 - 58.6	30.25	12.54	0.415	0.929	Non-parametric	36.32541	Modified-t UCL	58.6	*	58.6		58.6
Fluoranthene	10 / 14	71%	38.3 : 42	32 - 65.6	38.89	15.87	0.408	0.210	Normal	46.40206	Student's-t UCL	67.0	80.4	65.6	86.5	65.6
Phenanthrene	9 / 14	64%	38.3 : 42.9	22.9 - 83.2	31.15	16.57	0.532	2.644	G/NP	38.72714	Approximate Gamma UCL	83.2	*	83.2		83.2
Pyrene	11 / 14	79%	38.3 : 42	24.8 - 171	60.54	40.79	0.674	1.496	G/NP	84.3404	Approximate Gamma UCL			171		171
Pyrene (log-transformed)					3.901	0.671						161	277	171	370	161

Notes: 1. Sample SSRI17015000 is discarded for all compounds except Bis(2-chloroethyl)ether due to the extremely high detection limit for the other compounds in this sample.

2. For 15 samples, the non-parametric one-sided 95th percentile is the 15th ordered sample and for 14 samples, the 14th, i.e., the same as the maximum.

3. For 15 samples, the non-parametric 95% UCL on the mean is the 11th ordered sample; for 14 samples is the 10th.

4. The Student-t value for 15-1 = 14 degrees of freedom and 95% level of confidence is 1.761; for 13 df is 1.771.

5. The factor for a one-sided 95% coverage, 95% tolerance limit for 15 samples is 2.566; for 14 samples is 2.614.

6. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

7. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

8. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 13
Summary Statistics
Forest Soils by 8310

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
SVOCs (UG/KG)																
Benzo[a]anthracene	1 / 15	7%	1.91 : 21.5	25.2 - 25.2	9.28	5.79	0.624		Poisson				16	25.2		16
Benzo[a]pyrene	1 / 15	7%	1.91 : 21.5	12 - 12	8.57	3.59	0.419		Poisson				15.5	12		12
Fluoranthene	11 / 15	73%	1.91 : 42.4	16.3 - 48.4	23.45	13.14	0.560	0.429	Normal	29.42402	Student's-t UCL	46.6	57.2	48.4	62.9	46.6
Phenanthrene	7 / 15	47%	19.1 : 215	14.4 - 39.6	53.4	41.4	0.775	0.354	Non-parametric	99.99801	95% Chebyshev (Mean, Sd) UCL	107.5	*	39.6		39.6
Pyrene	10 / 15	67%	1.91 : 21	20.1 - 69.4	29.05	21.58	0.743	0.190	Normal	38.86243	Student's-t UCL	67.1	84.4	69.4	93.8	67.1

Notes: 1. For 15 samples, the non-parametric 95th percentile is the 15th ordered sample, i.e., the same as the maximum.

    2. For 15 samples, the non-parametric one-sided 95% UCL on the mean is the 11th ordered sample.

    3. The Student-t value for 15-1 = 14 degrees of freedom and 95% level of confidence is 1.761.

    4. The factor for a 95% coverage, 95% one-sided tolerance limit for 15 samples is 2.566.

    5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

    6. The mean and standard deviation are computed with NDs replaced with DL/2.

    7. Shaded cell highlights an ordered value that is a 1/2DL value.

Table 14
Summary Statistics
Forest Soils, Metals

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Metals (MG/KG except as noted)																		
Aluminum	15 / 15	100%	:		8490 -	16500	12368	2436.3	0.197	-0.042	Normal	13475.96	Student's-t UCL	16658	18620	16500	19677	16500
Arsenic	15 / 15	100%	:		4 -	14.1	8.71	2.81	0.323	0.631	Normal	9.985282	Student's-t UCL	13.7	15.9	14.1	17.1	13.7
Barium	10 / 15	67%	11.8 :	15.7	16.5 -	26.3	15.9	7.2	0.453	-0.265	Normal	19.17691	Student's-t UCL	28.6	34.4	26.3	37.5	26.3
Beryllium	15 / 15	100%	:		0.23 -	0.46	0.38	0.07	0.184	-0.782	Normal	0.411968	Student's-t UCL	0.50	0.56	0.46	0.59	0.46
Cadmium	2 / 15	13%	0.069 :	0.13	0.1 -	0.13	0.056	0.026	0.464	2.032	G/NP	0.067707	Approximate Gamma UCL	0.13	*	0.13		0.13
Calcium	15 / 15	100%	:		203 -	600	357.4	130.5	0.365	0.687	G/NP	423.2865	Approximate Gamma UCL	600	*	600		600
Chromium	15 / 15	100%	:		12.1 -	22.7	16.08	3.3	0.205	0.410	Normal	17.58282	Student's-t UCL	21.9	24.6	22.7	26.0	21.9
Cobalt	15 / 15	100%	:		1.4 -	4.3	2.79	0.94	0.337	0.408	Normal	3.222866	Student's-t UCL	4.45	5.22	4.30	5.61	4.3
Iron	15 / 15	100%	:		9070 -	15900	11640	2183.7	0.188	0.430	Normal	12633.08	Student's-t UCL	15485	17243	15900	18191	15485
Lead	15 / 15	100%	:		9.6 -	58.2	25.03	12.86	0.514	1.192	Normal	30.8795	Student's-t UCL	47.7	58.0	58.2	63.6	47.7
Magnesium	15 / 15	100%	:		1530 -	4220	2298.7	680.3	0.296	1.682	G/NP	2615.594	Approximate Gamma UCL	4220	*	4220		4220
Manganese	15 / 15	100%	:		46.1 -	241	93.23	47.6	0.511	2.329	G/NP	114.8991	Approximate Gamma UCL	241	*	241		241
Mercury (UG/KG)	13 / 15	87%	19.9 :	21.4	27.9 -	70.8	45.46	19.05	0.419	-0.628	Normal	54.12785	Student's-t UCL	79.0	94.4	70.8	102.6	70.8
Molybdenum (UG/KG)	15 / 15	100%	:		417 -	1220	587.2	198.4	0.338	2.587	Non-parametric	683.1194	Modified-t UCL	1220	*	1220		1220
Nickel	15 / 15	100%	:		6.1 -	14.4	9.81	1.97	0.201	0.504	Normal	10.70811	Student's-t UCL	13.3	14.9	14.4	15.7	13.3
Potassium	15 / 15	100%	:		335 -	1530	640.4	334.6	0.522	1.489	G/NP	805.218	Approximate Gamma UCL	1530		1530		1530
Silver	15 / 15	100%	:		0.022 -	0.11	0.051	0.022	0.431	1.330	Normal	0.061547	Student's-t UCL	0.090	0.108	0.110	0.117	0.09
Thorium (UG/KG)	15 / 15	100%	:		3570 -	7590	5142	1255.8	0.244	0.302	Normal	5713.098	Student's-t UCL	7353	8364	7590	8909	7353
Titanium (UG/KG)	15 / 15	100%	:		303000 -	661000	470933	108782	0.231	0.465	Normal	520403.9	Student's-t UCL	662498	750068	661000	797279	661000
Uranium	15 / 15	100%	:		0.67 -	1.3	1	0.257	0.257	-0.072	G/NP	1.136482	Approximate Gamma UCL	1.3	*	1.30		1.3
Vanadium	15 / 15	100%	:		14.4 -	29.7	19.68	3.63	0.184	1.376	Normal	21.32887	Student's-t UCL	26.1	29.0	29.7	30.6	26.1

Notes: 1. For 15 samples, the non-parametric 95th percentile is the 15th ordered sample, i.e., the same as the maximum.

2. For 15 samples, the non-parametric one-sided 95% UCL on the mean is the 11th ordered sample.

3. The Student-t value for 15-1 = 14 degrees of freedom and 95% level of confidence is 1.761.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 15 samples is 2.566.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

Table 15
Summary Statistics
Conant Well Property Surface Water

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects		Range of Detected Concentrations		Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Metals, Total (ug/L)																		
Aluminum	3 / 3	100%			222 -	449	305	--	--	--	--	--	--	--	--	449	--	449
Barium	3 / 3	100%			10.9 -	36	20.6	--	--	--	--	--	--	--	--	36	--	36
Beryllium	3 / 3	100%			0.028 -	0.074	0.046	--	--	--	--	--	--	--	--	0.074	--	0.074
Cadmium	1 / 3	33%	0.02 :	0.02	0.022 -	0.022	0.014	--	--	--	--	--	--	--	--	0.022	--	0.022
Calcium	3 / 3	100%			4960 -	8440	6250	--	--	--	--	--	--	--	--	8440	--	8440
Chromium	2.7				1.1 -	2.7	1.87	--	--	--	--	--	--	--	--	2.7	--	2.7
Cobalt	3 / 3	100%			0.44 -	1.1	0.68	--	--	--	--	--	--	--	--	1.1	--	1.1
Copper	2 / 3	67%	0.03 :	0.03	0.13 -	0.34	0.162	--	--	--	--	--	--	--	--	0.34	--	0.34
Iron	3 / 3	100%			454 -	1040	666	--	--	--	--	--	--	--	--	1040	--	1040
Lead	1 / 3	33%	0.52 :	0.56	1.7 -	1.7	0.747	--	--	--	--	--	--	--	--	1.7	--	1.7
Magnesium	3 / 3	100%			1360 -	2100	1620	--	--	--	--	--	--	--	--	2100	--	2100
Manganese	3 / 3	100%			20.8 -	77.6	41.5	--	--	--	--	--	--	--	--	77.6	--	77.6
Nickel	3 / 3	100%			0.77 -	1.3	0.973	--	--	--	--	--	--	--	--	1.3	--	1.3
Potassium	3 / 3	100%			856 -	1230	996	--	--	--	--	--	--	--	--	1230	--	1230
Sodium	3 / 3	100%			8280 -	72200	33960	--	--	--	--	--	--	--	--	72200	--	72200
Titanium	2 / 3	67%	2.5 :	2.5	3.1 -	11.2	5.18	--	--	--	--	--	--	--	--	11.2	--	11.2
Uranium	3 / 3	100%			0.19 -	0.22	0.203	--	--	--	--	--	--	--	--	0.22	--	0.22
Vanadium	1 / 3	33%	1 :	1	4.2 -	4.2	1.73	--	--	--	--	--	--	--	--	4.2	--	4.2
Zinc	3 / 3	100%			4.9 -	10.7	7.3	--	--	--	--	--	--	--	--	10.7	--	10.7
Hardness as CaCO3 **(mg/L)**	3 / 3	100%			18 -	29.7	22.3	--	--	--	--	--	--	--	--	29.7	--	29.7
Metals, Dissolved (ug/L)																		
Aluminum	3 / 3	100%			164 -	221	184	--	--	--	--	--	--	--	--	221	--	221
Barium	3 / 3	100%			9.3 -	29.3	22.4	--	--	--	--	--	--	--	--	29.3	--	29.3
Cadmium	1 / 3	33%	0.02 :	0.02	0.031 -	0.031	0.017	--	--	--	--	--	--	--	--	0.031	--	0.031
Calcium	3 / 3	100%			4810 -	8130	6830	--	--	--	--	--	--	--	--	8130	--	8130
Chromium	1 / 3	33%	0.5 :	0.5	0.62 -	0.62	0.373	--	--	--	--	--	--	--	--	0.62	--	0.62
Cobalt	3 / 3	100%			0.47 -	1.0	0.79	--	--	--	--	--	--	--	--	1.0	--	1.0
Copper	3 / 3	100%			0.49 -	0.62	0.543	--	--	--	--	--	--	--	--	0.62	--	0.62
Iron	3 / 3	100%			398 -	815	548	--	--	--	--	--	--	--	--	815	--	815
Lead	3 / 3	100%			0.71 -	1.0	0.817	--	--	--	--	--	--	--	--	1.0	--	1.0
Magnesium	3 / 3	100%			1250 -	1840	1617	--	--	--	--	--	--	--	--	1840	--	1840
Manganese	3 / 3	100%			20 -	72.9	50.5	--	--	--	--	--	--	--	--	72.9	--	72.9
Nickel	3 / 3	100%			1.4 -	2.3	1.83	--	--	--	--	--	--	--	--	2.3	--	2.3
Potassium	3 / 3	100%			775 -	1200	1045	--	--	--	--	--	--	--	--	1200	--	1200
Sodium	3 / 3	100%			9480 -	83700	57727	--	--	--	--	--	--	--	--	83700	--	83700
Titanium	3 / 3	100%			1.5 -	1.8	1.63	--	--	--	--	--	--	--	--	1.8	--	1.8
Uranium	3 / 3	100%			0.13 -	0.18	0.147	--	--	--	--	--	--	--	--	0.18	--	0.18
Zinc	3 / 3	100%			5.5 -	8.9	7.10	--	--	--	--	--	--	--	--	8.9	--	8.9

-- - Not Applicable; not be calculated for data sets with 3 samples.

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\ Spring 2005 - SumStatsFinal.xls, Conant SW

Page 1 of 1

1/3/2006

Table 16
Summary Statistics
Conant Well Property Sediment

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Semivolatile Organics (8270C)																
(ug/Kg)																
Benzo[a]pyrene	3 / 10	30%	97 : 152	111 - 516	143	162.9	1.156	1.878	Non-Parametric	371	95% Chebyshev (Mean, Sd) UCL	516	*	516		516
Benzo[b]fluoranthene	4 / 10	40%	97 : 151	78.1 - 417	152	149.5	0.985	1.104	Non-Parametric	359	95% Chebyshev (Mean, Sd) UCL	417	*	417		417
Benzoic Acid	3 / 10	30%	1860 : 3020	3530 - 3970	1910	1350.8	0.675	0.983	Non-Parametric	3685	95% Chebyshev (Mean, Sd) UCL	3970	*	3970		3970
Bis(2-Ethylhexyl)phthalate	3 / 10	30%	495 : 996	481 - 531	422	161.4	0.249	-0.762	Non-Parametric	482	Student's-t UCL [a]	531	*	531		531
Chrysene	5 / 10	50%	97 : 151	62.8 - 119	76.3	34.7	0.359	0.391	Normal	92.2	Student's-t UCL	126	156	119	180	119
Fluoranthene	7 / 10	70%	99 : 151	61.5 - 176	92.5	47.1	0.432	1.184	Non-Parametric	116	Student's-t UCL [a]	176	*	176		176
Indeno[1,2,3-cd]pyrene	1 / 10	10%	93 : 152	532 - 532	107	145.7	1.401	3.126	Poisson				185	532		185
Phenanthrene	5 / 10	50%	97 : 151	53 - 87	60.7	22.8	0.237	1.053	Non-Parametric	69.3	Mod-t UCL (Adjusted for skewness)	87	*	87		87
Pyrene	9 / 10	90%	99 : 99	60.5 - 192	116	60.3	0.443	0.329	Normal	146	Student's-t UCL	211	267	192	297	192
Polyaromatic Hydrocarbons (8310)																
(ug/Kg)																
Benzo[a]anthracene	5 / 6	83%	4.95 : 4.95	39.8 - 140	52.6	45.9			Normal			145	223	140	190	
Benzo[a]anthracene (outlier removed)	4 / 4	100%		39.8 - 49	43.3	19.8	0.102	0.748	Normal	48.5	Student's-t UCL	53.7	66.1	49	102.6	49
Benzo[a]pyrene	5 / 6	83%	16.1 : 16.1	19.6 - 38.5	26.0	14.2	0.433	-0.686		35.3	Student's-t UCL	48.8	67.8	38.5	68.8	38.5
Benzo[b]fluoranthene	1 / 6	17%	16.1 : 50.2	53.9 - 53.9	23.6	17.1	0.679	1.669	Non-Parametric	36.8	Student's-t UCL [a]	53.9	*	53.9		53.9
Chrysene	5 / 6	83%	4.95 : 4.95	34 - 118	45.4	38.4			Normal			123	187.9	118	161	
Chrysene (outlier removed)	4 / 4	100%		34 - 43.9	37.9	17.4	0.111	1.317	Normal	42.9	Student's-t UCL	47.8	59.6	43.9	90.0	43.9
Fluoranthene	6 / 6	100%		40 - 184	81.3				Lognormal					184		
Log-transformed					4.3	0.52			Lognormal			203	487	184	337	
Fluoranthene (outlier removed)	5 / 5	100%		40 - 72.4	60.7	27.9	0.235	-0.901	Normal	74.3	Student's-t UCL	91.1	121	72.4	144	72.4
Phenanthrene	6 / 6	100%		32.3 - 120	58.0	0.5	1.954	1.048	G/NP	92.0	Approximate Gamma UCL	120	*	120		120
Pyrene	6 / 6	100%		46.9 - 147	78.1				Lognormal					147		
Log-transformed					4.3	0.39			Lognormal			160	309	147	234	
Pyrene (outlier removed)	5 / 5	100%		46.9 - 76.4	64.3	28.5	0.192	-0.727	Normal	76.1	Student's-t UCL	91.1	116	76.4	150	76.4
Inorganics (mg/Kg)																
Aluminum	10 / 10	100%		10900 - 27400	22000	4891	0.222	-1.420	Normal	24835	Student's-t UCL	30964	36236	27400	36672	27400
Arsenic	10 / 10	100%		3.8 - 9.8	7.61	2.10	0.276	-0.765	Normal	8.83	Student's-t UCL	11.5	13.7	9.8	13.9	9.8
Barium	10 / 10	100%		37.1 - 74.4	49.7	10.20			Normal			68.4	79.4	74.4	80.3	
Barium (outlier removed)	9 / 9	100%		37.1 - 54.2	47.0	5.67	0.121	-0.463	Normal	50.4	Student's-t UCL	57.3	64.1	54.2	64.0	54.2
Beryllium	10 / 10	100%		0.88 - 3.9	2.24	1.07	0.479	0.376	Normal	2.86	Student's-t UCL	4.20	5.36	3.9	5.45	3.9
Cadmium	9 / 10	90%	0.32 : 0.32	0.26 - 1	0.529	0.24	0.448	0.468	Normal	0.666	Student's-t UCL	0.97	1.22	1	1.25	0.97
Calcium	10 / 10	100%		1060 - 3310	1839	718	0.391	0.753	Normal	2255	Student's-t UCL	3156	3930	3310	3994	3156
Chromium	10 / 10	100%		13.9 - 29.7	23.0	4.38	0.191	-0.601	Normal	25.5	Student's-t UCL	31.0	35.7	29.7	36.1	29.7
Cobalt	10 / 10	100%		1.8 - 4.9	3.13	0.92	0.294	0.691	Normal	3.66	Student's-t UCL	4.82	5.8	4.9	5.89	4.82
Copper	5 / 10	50%	11.4 : 13.4	16.3 - 23.5	12.5		0.550	0.309	Non-Parametric	22.0	95% Chebyshev (Mean, Sd) UCL	23.5	*	23.5		23.5
Iron	10 / 10	100%		3560 - 9520	6409	1816	0.283	0.427	Normal	7461	Student's-t UCL	9738	11694	9520	11857	9520
Lead	10 / 10	100%		52.7 - 300	99.8		0.753	2.547	Non-Parametric	203	95% Chebyshev (Mean, Sd) UCL	300	*	300		300
Magnesium	10 / 10	100%		1020 - 2710	1867	545	0.292	0.008	Normal	2183	Student's-t UCL	2866	3453	2710	3501	2710
Manganese	10 / 10	100%		37.3 - 84	61.6	14.33	0.232	0.041	Normal	69.9	Student's-t UCL	88	103	84	105	84
Mercury	10 / 10	100%		0.068 - 0.161	0.116	0.03	0.288	-0.257	Normal	0.135	Student's-t UCL	0.176	0.212	0.161	0.215	0.161
Molybdenum	10 / 10	100%		1.01 - 2.6	1.67	0.62	0.372	0.461	Normal	2.03	Student's-t UCL	2.81	3.47	2.6	3.53	2.6
Nickel	10 / 10	100%		9.2 - 17	14.0	2.26	0.162	-0.767	Normal	15.3	Student's-t UCL	18.2	20.6	17	20.8	17
Potassium	10 / 10	100%		430 - 751	595	87	0.146	-0.173	Normal	646	Student's-t UCL	755	849	751	857	751
Selenium	7 / 10	70%	1.1 : 2.4	2.5 - 4.2	2.43	1.18	0.488	-0.392	Normal	3.11	Student's-t UCL	4.59	5.87	4.2	5.97	4.2
Silver	10 / 10	100%		0.082 - 0.16	0.112	0.03	0.230	0.569	Normal	0.127	Student's-t UCL	0.159	0.186	0.16	0.190	0.159
Sodium	10 / 10	100%		629 - 2540	1070				Non-Parametric					2540		
Sodium (outlier removed)	9 / 9	100%		629 - 1170	907	906	0.179	-0.247	Normal	1007	Student's-t UCL	2592	1398	1170	3625	1170
Thallium	6 / 10	60%	0.17 : 0.25	0.17 - 0.32	0.194	0.08	0.427	0.222	Normal	0.241	Student's-t UCL	0.346	0.43	0.32	0.443	0.32
Thorium	10 / 10	100%		0.38 - 2.34	1.09		0.642	1.138	G/NP	1.61	Approximate Gamma UCL			2.34		
Log-transformed					-0.08	0.61			Lognormal			2.83	5.48	2.34	5.79	2.34
Titanium	10 / 10	100%		282 - 727	493	130	0.264	0.052	Normal	568	Student's-t UCL	731	871	727	883	727
Tungsten	4 / 10	40%	0.3 : 0.3	0.3 - 0.37	0.515		0.467	-0.177	Non-Parametric	0.819	95% H-UCL [a]	0.37	*	0.37		0.37
Uranium	10 / 10	100%		1.9 - 22.6	10.5	7.82	0.745	0.215	Normal	15.0	Student's-t UCL	24.8	33.3	22.6	34.0	22.6
Vanadium	10 / 10	100%		14.5 - 28.8	23.6	4.53	0.192	-0.925	Normal	26.2	Student's-t UCL	36.8	36.8	28.8	37.2	28.8
Zinc	5 / 10	50%	30.7 : 48.3	34.4 - 78.6	32.5		0.556	2.081	G/NP	44.0	Approximate Gamma UCL			78.6		
Log-transformed					3.4	0.46			Lognormal			113	113	78.6	117	78.6
Zirconium	7 / 10	70%	0.336 : 0.41	0.495 - 1.9	1.00	0.68	0.025	0.408	Normal	67.8	Student's-t UCL	2.24	2.97	1.90	3.03	1.90

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Spring 2005 - SumStatsFinal.xls, Conant Sed

Page 1 of 2

1/5/2006

Table 16
Summary Statistics
Conant Well Property Sediment

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL

Notes: 1. For 5 samples, the non-parametric 95th percentile is the 5th ordered sample, i.e., the same as the maximum.
    For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum

2. For 5 samples, the non-parametric one-sided 95% UCL on the mean is the 4th ordered sample.
    For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 5-1 = 4 degrees of freedom and 95% level of confidence is 2.132.
    The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833, for 8 df is 1.860.

4. The factor for a one-sided 95% coverage, 95% tolerance limit is 4.202.
    The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911, and for 9 samples 3.023.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Spring 2005 - SumStatsFinal.xls, Conant Sed

Page 2 of 2

1/5/2006

Table 17
Summary Statistics
Hudson Bog Surface Water

Parameter	Frequency of Detection			Percent Detected	Range of NonDetects			Range of Detected Concentrations			Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Metals, Total (ug/L)																						
Aluminum	10	/	10	100%				178	-	319	266	42.0	0.158	-0.88	Normal	290	Student's-t UCL	343	388	319	392	319
Barium	10	/	10	100%				15.3	-	26.4	19.1	3.14	0.164	1.29	Normal	21.0	Student's-t UCL	24.9	28.3	26.4	28.6	24.9
Beryllium	10	/	10	100%				0.023	-	0.048	0.0363	0.00766	0.211	-0.26	Normal	0.041	Student's-t UCL	0.0503	0.0590	0.0480	0.0593	0.0480
Cadmium	10	/	10	100%				0.091	-	0.15	0.112	0.0153	0.137	1.68	Non-parametric	0.121	Mod-t UCL (Adjusted for skewness)	0.15	*	0.15		0.15
Calcium	10	/	10	100%				2490	-	3460	3067	311	0.101	-0.66	Normal	3247	Student's-t UCL	3638	3973	3460	4001	3460
Chromium	10	/	10	100%				1.1	-	3.3	2.04	0.628	0.308	0.72	Normal	2.40	Student's-t UCL	3.19	3.87	3.3	3.92	3.19
Cobalt	10	/	10	100%				0.48	-	1.3	0.857	0.248	0.289	0.06	Normal	1.000	Student's-t UCL	1.31	1.58	1.30	1.60	1.30
Copper	10	/	10	100%				1.2	-	3.2	2.21	0.578	0.262	0.14	Normal	2.55	Student's-t UCL	3.27	3.89	3.20	3.94	3.20
Iron	10	/	10	100%				245	-	837	573	194	0.339	-0.54	Normal	685	Student's-t UCL	929	1138	837	1155	837
Lead	10	/	10	100%				1	-	5	2.06	1.30	0.631	1.75	Lognormal	3.02	95% H-UCL			5		
Log-transformed											0.586	0.515			Lognormal			4.62	8.04	5.00	2.13	2.13
Magnesium	10	/	10	100%				765	-	947	860	66.4	0.077	0.01	Normal	898	Student's-t UCL	981	1053	947	1059	947
Manganese	10	/	10	100%				100	-	237	135	43.6	0.323	1.69	G/NP	162	Approximate Gamma UCL			237		
Log-transformed											5	0.282			Lognormal			217	295	237	302	217
Nickel	10	/	10	100%				1.2	-	2.2	1.68	0.278	0.166	0.10	Normal	1.84	Student's-t UCL	2.19	2.49	2.20	2.51	2.19
Potassium	10	/	10	100%				1670	-	2000	1835	101	0.055	-0.17	Normal	1893	Student's-t UCL	2020	2128	2000	2137	2000
Silver	1	/	10	10%	0.008	:	0.033	0.026	-	0.026	0.0103	0.00655	0.639	1.80	Poisson					0.0400	0.0260	0.0260
Sodium	10	/	10	100%				16400	-	22600	19700	1599	0.081	-0.37	Normal	20627	Student's-t UCL	22630	24353	22600	24496	22600
Thallium	4	/	10	40%	0.023	:	0.05	0.055	-	0.35	0.0692	0.10	1.491	2.72	Non-parametric	0.152	95% Chebyshev (MVUE) UCL [a]	0.35	*	0.35		0.35
Titanium	10	/	10	100%				3.8	-	7.9	5.66	1.29	0.228	0.37	Normal	6.41	Student's-t UCL	8.02	9.42	7.90	9.54	7.90
Tungsten	1	/	10	10%	0.15	:	0.4	0.87	-	0.87	0.198	0.240	1.213	3.01	Poisson					0.550	0.870	0.55
Uranium	2	/	10	20%	0.015	:	0.033	0.036	-	0.039	0.0182	0.0106	0.581	1.47	Non-parametric	0.027	95% H-UCL [a]	0.0390	*	0.0390		0.0390
Zinc	10	/	10	100%				22.5	-	45.5	34.4	5.99	0.174	-0.13	Normal	37.9	Student's-t UCL	45.4	51.9	45.5	52.4	45.4
Zirconium	2	/	10	20%	0.5	:	0.5	1.1	-	1.1	0.42	0.358	0.853	1.78	Non-parametric	0.914	95% Chebyshev (Mean, Sd) UCL	1.10	*	1.10		1.10
Hardness as CaCO3 (mg/L)	10	/	10	100%				9.37	-	12.5	11.2	1.03			Normal			13.1	14.2	12.5	14.3	12.5
Metals, Dissolved (ug/L)																						
Aluminum	10	/	10	100%				143	-	257	204	40.7	0.199	-0.10	Normal	228	Student's-t UCL	279	323	257	326	257
Barium	10	/	10	100%				11.8	-	15.9	13.7	1.39	0.102	0.36	Normal	14.51	Student's-t UCL	16.2	17.8	15.9	18	15.9
Beryllium	7	/	10	70%	0.02	:	0.041	0.024	-	0.081	0.0439	0.0257	0.587	0.17	Normal	0.0588	Student's-t UCL	0.0910	0.1190	0.0810	0.121	0.0810
Cadmium	10	/	10	100%				0.072	-	0.13	0.0897	0.0183	0.204	1.36	Normal	0.100	Student's-t UCL	0.123	0.143	0.130	0.145	0.123
Calcium	10	/	10	100%				2270	-	3150	2782	301	0.108	-0.28	Normal	2956	Student's-t UCL	3333	3657	3150	3684	3150
Chromium	10	/	10	100%				1	-	2.3	1.56	0.331	0.212	0.81	Normal	1.75	Student's-t UCL	2.16	2.52	2.30	2.55	2.16
Cobalt	10	/	10	100%				0.42	-	1.5	0.801	0.307	0.384	1.195	Normal	0.979	Student's-t UCL	1.37	1.70	1.50	1.72	1.37
Copper	10	/	10	100%				1.5	-	2.2	1.96	0.232	0.118	-0.93	Normal	2.09	Student's-t UCL	2.38	2.64	2.20	2.66	2.20
Iron	10	/	10	100%				157	-	697	465	175	0.375	-0.39	Normal	566	Student's-t UCL	785	973	697	989	697
Lead	10	/	10	100%				1.2	-	2.3	1.66	0.347	0.209	0.62	Normal	1.86	Student's-t UCL	2.30	2.67	2.30	2.70	2.30
Magnesium	10	/	10	100%				647	-	830	753	62.5	0.083	-0.46	Normal	789	Student's-t UCL	867	935	830	940	830
Manganese	10	/	10	100%				92.2	-	202	124	34.5	0.279	1.528	G/NP	145	Approximate Gamma UCL			202		
Log-transformed											5	0.25			Lognormal			190	249	202	254	190
Mercury	4	/	10	40%	0.033	:	0.033	0.035	-	0.048	0.0267	0.014	0.508	0.686	Non-parametric	0.0347	Mod-t UCL (Adjusted for skewness)	0.048	*	0.048		0.048
Nickel	10	/	10	100%				2	-	3.1	2.29	0.328	0.143	1.88	G/NP	2.48	Approximate Gamma UCL			3.10		
Log-transformed											0.82	0.132			Lognormal			2.89	3.33	3.10	3.37	2.89
Potassium	10	/	10	100%				1650	-	1920	1814	84.2	0.046	-0.55	Normal	1863	Student's-t UCL	1968	2059	1920	2067	1920
Sodium	10	/	10	100%				17500	-	24600	20900	2035	0.097	-0.02	Normal	22080	Student's-t UCL	24630	26824	24600	27006	24600
Thallium	1	/	10	10%	0.047	:	0.15	0.39	-	0.39	0.0743	0.112	1.51	3.07	Poisson					0.39	0.14	0.14
Titanium	10	/	10	100%				2.4	-	3.5	3.05	0.354	0.116	-0.42	Normal	3.25	Student's-t UCL	3.70	4.08	3.50	4.11	3.50
Uranium	10	/	10	100%				0.008	-	0.026	0.0171	0.0048	0.283	-0.02	Normal	0.0199	Student's-t UCL	0.0259	0.031	0.026	0.0316	0.0259
Zinc	10	/	10	100%				22.1	-	38.1	29.7	4.96	0.167	0.19	Normal	32.6	Student's-t UCL	38.8	44.1	38.1	44.6	38.1
Zirconium	1	/	10	10%	0.5	:	0.5	0.53	-	0.53	0.278	0.0885	0.319	3.162	Poisson					0.7	0.53	0.530

Notes: 1. For 10 samples, the non-parametric 95th percentile is the 10th ordered sample, i.e., the same as the maximum.

2. For 10 samples, the non-parametric one-sided 95% UCL on the mean is the 8th ordered sample.

3. The Student-t value for 10-1 = 9 degrees of freedom and 95% level of confidence is 1.833, for 8 df is 1.860.

4. The factor for a one-sided 95% coverage, 95% tolerance limit for 10 samples is 2.911, and for 9 samples 3.023.

5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.

6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.

7. The mean and standard deviation are computed with NDs replaced with DL/2.

[a] The chemstat software characterized the distriubtion as NP; whereas ProUCL software characterized the distribution as N or LN. Therefore, the upper limits are developed assuming a NP distribution and the 95% UCL is developed assuming the N or LN distribution.

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Spring 2005 - SumStatsFinal.xls, HB SW

Page 1 of 1

1/5/2006

Table 18
Summary Statistics
Hudson Bog Sediment

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean
Semivolatile Organics (ug/Kg)					
Benzo[b]fluoranthene	1 / 4	25%	103 : 116	109 - 109	67.5
Benzoic Acid	2 / 4	50%	2060 : 2320	1300 - 1500	1248
Bis(2-Chloroethyl)ether	1 / 4	25%	1030 : 1340	231 - 231	499
Diethylphthalate	2 / 4	50%	1030 : 1030	397 - 521	487
Fluoranthene	1 / 4	25%	103 : 134	89 - 89	64.8
m+pMethylphenol	2 / 4	50%	1030 : 1340	705 - 3100	1248
Phenanthrene	3 / 4	75%	103 : 103	72 - 85	70.1
Phenol	3 / 4	75%	1030 : 1030	363 - 921	544
Pyrene	1 / 4	25%	103 : 134	111 - 111	70.3
Inorganics (mg/Kg)					
Mercury	4 / 4	100%		0.037 - 0.061	0.0463
Aluminum	4 / 4	100%		2670 - 4950	3520
Arsenic	4 / 4	100%		1.1 - 3.8	2.78
Barium	4 / 4	100%		9.1 - 40.1	25.3
Beryllium	4 / 4	100%		0.15 - 0.42	0.310
Cadmium	4 / 4	100%		0.088 - 0.38	0.245
Calcium	4 / 4	100%		170 - 1830	817
Chromium	4 / 4	100%		3.9 - 6.7	5.13
Cobalt	4 / 4	100%		0.54 - 1.5	0.98
Copper	4 / 4	100%		1.7 - 8.3	5.30
Iron	4 / 4	100%		1990 - 4440	2930
Lead	4 / 4	100%		13.2 - 30.6	24.6
Magnesium	4 / 4	100%		141 - 429	299
Manganese	4 / 4	100%		12.1 - 20.8	17.3
Molybdenum	2 / 4	50%	0.19 : 0.45	0.83 - 0.85	0.500
Nickel	4 / 4	100%		2.6 - 4.8	3.85
Potassium	4 / 4	100%		144 - 244	210
Selenium	4 / 4	100%		0.4 - 1.8	1.23
Silver	3 / 4	75%	0.026 : 0.026	0.078 - 0.1	0.0683
Sodium	4 / 4	100%		59.9 - 319	175
Thallium	4 / 4	100%		0.036 - 0.061	0.049
Thorium	4 / 4	100%		0.73 - 2.8	1.83
Titanium	4 / 4	100%		65.7 - 157	113
Tungsten	3 / 4	75%	0.086 : 0.086	0.32 - 0.44	0.301
Uranium	4 / 4	100%		0.76 - 1.4	1.09
Vanadium	4 / 4	100%		4.5 - 9.2	7.38
Zinc	4 / 4	100%		6.8 - 28.2	16.1
Zirconium	4 / 4	100%		1.2 - 1.6	1.3

Notes: 1. The mean is computed with NDs replaced with DL/2.

Table 19
Summary Statistics
Hudson Bog Peat

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean
Semivolatile Organics (ug/Kg)					
Benzo[a]anthracene	1 / 11	9%	102 : 188	78 - 78	65.1
Benzo[b]fluoranthene	5 / 11	45%	102 : 153	122 - 373	128
Benzo[k]fluoranthene	3 / 11	27%	102 : 188	70 - 77	66.6
Benzoic Acid	7 / 11	64%	2030 : 2430	676 - 4520	1674
Butylbenzylphthalate	1 / 11	9%	1020 : 1880	2390 - 2390	784
Chrysene	4 / 11	36%	102 : 153	53 - 122	70.9
Diethylphthalate	3 / 11	27%	1020 : 1880	296 - 15700	1944
Fluoranthene	6 / 11	55%	102 : 153	62 - 200	97.1
m+pMethylphenol	7 / 11	64%	1020 : 1880	2210 - 6960	3078
Phenanthrene	9 / 11	82%	102 : 131	54 - 133	85.3
Phenol	4 / 11	36%	1020 : 1880	229 - 2010	790
Pyrene	8 / 11	73%	122 : 153	50 - 179	103
Inorganics (mg/Kg)					
Aluminum	11 / 11	100%		2370 - 5310	3478
Arsenic	11 / 11	100%		1.7 - 4	3.26
Barium	11 / 11	100%		15.4 - 47.5	29.5
Beryllium	11 / 11	100%		0.17 - 0.54	0.348
Cadmium	11 / 11	100%		0.19 - 0.46	0.319
Calcium	11 / 11	100%		245 - 1960	1150
Chromium	11 / 11	100%		3.8 - 8	4.91
Cobalt	11 / 11	100%		0.52 - 1.6	1.14
Copper	11 / 11	100%		3.1 - 10.3	7.56
Iron	11 / 11	100%		1610 - 3500	2823
Lead	11 / 11	100%		18.1 - 60.7	36.1
Magnesium	11 / 11	100%		110 - 380	224
Manganese	11 / 11	100%		7.9 - 38	19.1
Mercury	11 / 11	100%		0.038 - 0.078	0.0543
Molybdenum	9 / 11	82%	0.31 : 0.43	0.48 - 1	0.717
Nickel	11 / 11	100%		2.7 - 5.7	4.43
Potassium	11 / 11	100%		165 - 378	246
Selenium	11 / 11	100%		0.67 - 2.1	1.59
Silver	11 / 11	100%		0.05 - 0.14	0.0969
Sodium	11 / 11	100%		74.9 - 389	238
Thallium	11 / 11	100%		0.036 - 0.075	0.0498
Thorium	11 / 11	100%		0.39 - 2	1.12
Titanium	11 / 11	100%		66.3 - 157	94.2
Tungsten	9 / 11	82%	0.2 : 0.29	0.26 - 1.3	0.55
Uranium	11 / 11	100%		0.7 - 2.2	1.16
Vanadium	11 / 11	100%		5.5 - 12.1	9.01
Zinc	11 / 11	100%		9.7 - 29.3	19.6
Zirconium	11 / 11	100%		1 - 1.6	1.25

Notes: 1. The mean is computed with NDs replaced with DL/2.

Table 20
Summary Statistics
Hudson Bog Sediment and Peat Combined

Parameter	Frequency of Detection	Percent Detected	Range of NonDetects	Range of Detected Concentrations	Mean	Std Dev	CV	Skewness	Distribution	95% UCL on the mean	Method	95th Percentile	95/95 UTL	Maximum Detected	Mean + 3 SD	Recommended UL
Semivolatile Organics (ug/Kg)																
Benzo[a]anthracene	1 / 15	7%	102 : 188	78 - 78	63.0	12.3	0.195	1.24	Poisson				134	78		78
Benzo[b]fluoranthene	6 / 15	40%	102 : 153	109 - 373	112	90.1	0.806	2.02	Non-parametric	213	95% Chebyshev (Mean, Sd) UCL	373	*	373		373
Benzo[k]fluoranthene	3 / 15	20%	102 : 188	70 - 77	64.0	12.4	0.194	0.899	Non-parametric	69.7	Student's-t UCL [a]	77	*	77		77
Benzoic Acid	9 / 15	60%	2030 : 2430	676 - 4520	1560	1076	0.690	2.21	Non-parametric	2771	95% Chebyshev (Mean, Sd) UCL	4520	*	4520		4520
Bis(2-chloroethyl)ether	1 / 15	7%		231 - 231		151	0.252	-0.191	Poisson				1150	231		231
Butylbenzylphthalate	1 / 15	7%	1020 : 1880	2390 - 2390	727	473	0.650	3.55	Poisson				1600	2390		1600
Chrysene	4 / 15	27%	102 : 153	53 - 122	67.1	19.4	0.289	1.85	G/NP	76.0	Approximate Gamma UCL	122		122		122
Diethylphthalate	5 / 15	33%	1020 : 1880	296 - 15700	1555	25.2	0.400	-0.089	Non-parametric			15700	*	15700		
Diethylphthalate (outlier removed)	4 / 14	29%	1020 : 1880	296 - 521	545	157	0.288	0.797	Non-parametric	619	Student's-t UCL [a]	521	*	521		521
Fluoranthene	7 / 15	47%	102 : 153	62 - 200	88.4	47.3	0.535	1.54	Non-parametric	111	Mod-t UCL (Adjusted for skewness)	200	*	200		200
m+pMethylphenol	9 / 15	60%	1020 : 1880	705 - 6960	2590	2201	0.850	0.669	G/NP	4097	Approximate Gamma UCL	6960	*	6960		6960
Phenanthrene	12 / 15	80%	102 : 131	54 - 133	81.2	24.7	0.304	0.821	Normal	92.5	Student's-t UCL	125	145	133	155	125
Phenol	7 / 15	47%	1020 : 1880	229 - 2010	724	421	0.580	2.14	G/NP	929	Approximate Gamma UCL	2010	*	2010		2010
Pyrene	9 / 15	60%	122 : 153	50 - 179	94	47.5	0.503	1.02	G/NP	118	Approximate Gamma UCL	179	*	179		179
Inorganics (mg/Kg)																
Aluminum	15 / 15	100%		2370 - 5310	3489	848	0.243	0.982	Normal	3875	Student's-t UCL	4982	5664	5310	6032	4982
Arsenic	15 / 15	100%		1.1 - 4.0	3.13	0.918	0.293	-1.09	Non-parametric	3.54	Mod-t UCL (Adjusted for skewness)	4.00	*	4.00		4.00
Barium	15 / 15	100%		9.1 - 47.5	28.4	9.97	0.351	-0.127	Normal	32.9	Student's-t UCL	46.0	54.0	47.5	58.3	46.0
Beryllium	15 / 15	100%		0.15 - 0.54	0.338	0.122	0.362	-0.078	Normal	0.394	Student's-t UCL	0.554	0.652	0.540	0.705	0.540
Cadmium	15 / 15	100%		0.088 - 0.46	0.299	0.105	0.350	-0.258	Normal	0.347	Student's-t UCL	0.484	0.568	0.460	0.613	0.460
Calcium	15 / 15	100%		170 - 1960	1061	630	0.594	-0.025	Normal	1348	Student's-t UCL	2171	2678	1960	2952	1960
Chromium	15 / 15	100%		3.8 - 8.0	4.97	1.19	0.239	1.46	Lognormal	5.52	Approximate Gamma UCL			8.00		
Log-transformed					1.58	0.216			Lognormal			7.09	8.45	8.00	9.27	7.09
Cobalt	15 / 15	100%		0.52 - 1.6	1.10	0.371	0.338	-0.431	Normal	1.27	Student's-t UCL	1.75	2.05	1.60	2.21	1.60
Copper	15 / 15	100%		1.7 - 10.3	6.96	2.93	0.420	-0.647	Non-parametric	10.3	95% Chebyshev (Mean, Sd) UCL	10.3	*	10.3		10.3
Iron	15 / 15	100%		1610 - 4440	2851	809	0.284	-0.005	Normal	3219	Student's-t UCL	4276	4927	4440	5278	4276
Lead	15 / 15	100%		13.2 - 60.7	33.1	12.6	0.381	0.858	Normal	38.8	Student's-t UCL	55.2	65.4	60.7	70.8	55.2
Magnesium	15 / 15	100%		110 - 429	244	104	0.424	0.352	Normal	291	Student's-t UCL	426	510	429	555	426
Manganese	15 / 15	100%		7.9 - 38	18.6	7.14	0.383	1.38	Normal	21.9	Student's-t UCL	31.2	37.0	38.0	40.1	31.2
Mercury	15 / 15	100%		0.038 - 0.078	0.0521	0.0132	0.253	0.694	Normal	0.058	Student's-t UCL	0.0754	0.0860	0.0780	0.0917	0.0754
Molybdenum	11 / 15	73%	0.19 : 0.45	0.48 - 1.0	0.659	0.329	0.498	-0.797	Non-parametric	1.03	95% Chebyshev (Mean, Sd) UCL	1.00	*	1.00		1.00
Nickel	15 / 15	100%		2.6 - 5.7	4.27	1.04	0.244	-0.422	Normal	4.75	Student's-t UCL	6.11	6.95	5.70	7.40	5.70
Potassium	15 / 15	100%		144 - 378	236	55.3			Normal			333	378	378	402	
Potassium (outlier removed)	14 / 14	100%		144 - 254	226	55.3	0.234	1.01	Normal	261	Student's-t UCL	324	332	254	392	254
Selenium	15 / 15	100%		0.4 - 2.1	1.49	0.508	0.341	-0.980	Non-parametric	1.72	Mod-t UCL (Adjusted for skewness)	2.10	*	2.10		2.10
Silver	14 / 15	93%	0.03 : 0.026	0.05 - 0.14	0.0893	0.0322	0.361	-0.758	Normal	0.104	Student's-t UCL	0.146	0.172	0.14	0.186	0.140
Sodium	15 / 15	100%		59.9 - 389	221	110	0.496	-0.261	Normal	271	Student's-t UCL	415	503	389	551	389
Thallium	15 / 15	100%		0.036 - 0.075	0.0496	0.0109	0.219	0.975	Normal	0.055	Student's-t UCL	0.0688	0.0780	0.0750	0.0822	0.0688
Thorium	15 / 15	100%		0.39 - 2.8	1.31	0.699	0.535	0.464	Normal	1.63	Student's-t UCL	2.54	3.10	2.80	3.40	2.54
Titanium	15 / 15	100%		66.3 - 157	99.2	31.8	0.321	0.831	Lognormal	115	Approximate Gamma UCL			157		
Log-transformed					4.6	0.304			Lognormal			162	207	157	236	157
Tungsten	12 / 15	80%	0.09 : 0.29	0.26 - 1.3	0.49	0.344	0.707	1.16	Normal	0.643	Student's-t UCL	1.09	1.37	1.30	1.52	1.09
Uranium	15 / 15	100%		0.7 - 2.2	1.14	0.397	0.348	1.48	Lognormal	1.33	Approximate Gamma UCL			2.20		
Log-transformed					0.0846	0.314			Lognormal			1.89	2.44	2.20	2.79	1.89
Vanadium	15 / 15	100%		4.5 - 12.1	8.57	2.24	0.261	-0.186	Normal	9.59	Student's-t UCL	12.5	14.3	12.1	15.3	12.1
Zinc	15 / 15	100%		6.8 - 29.3	18.7	7.34	0.393	0.089	Normal	22.0	Student's-t UCL	31.6	37.5	29.3	40.7	29.3
Zirconium	15 / 15	100%		1 - 1.6	1.27	0.180	0.142	0.748	Normal	1.35	Student's-t UCL	1.58	1.73	1.60	1.81	1.58

Notes: 1. For 15 samples, the non-parametric 95th percentile is the 15th ordered sample, i.e., the same as the maximum.
2. For 15 samples, the non-parametric one-sided 95% UCL on the mean is the 11th ordered sample.
3. The Student-t value for 15-1 = 14 degrees of freedom and 95% level of confidence is 1.761.
4. The factor for a one-sided 95% coverage, 95% tolerance limit for 15 samples is 2.566.
5. * - To determine a one-sided 95/95 UTL for a non-parametric distribution requires more samples than available.
6. G/NP - PROUCL recommended a gamma distribution for determining the 95% UCL on the mean, other statistics generated assuming a non-parametric distribution.
7. The mean and standard deviation are computed with NDs replaced with DL/2.

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
Spring 2005 - SumStatsFinal.xls, HB Combined

Page 1 of 2

1/5/2006

Table 21
Results of Outlier Testing

Data Set	Parameter	Possible Outliers (Dixon's Test at 95%)		Comments
		Raw	Log-transformed	
SW-Assabet-Up-TOTAL	Aluminum	916, 4790	None	
	Barium	33.3, 89.1	33.3, 89.1	Next highest at 18.6
10 Samples	Chromium	10.9, 52.2	None	
	Cobalt	2.1, 8	None	
Sample 17002 contains	Iron	105U, 2430, 8690	105U	1/2 DL - next low 545
substantially higher value	Lead	20.5J, 84.5J	None	
than any other sample -	Magnesium	5930	5930	Next highest at 4640
maximums for 23 analytes	Manganese	48.7, 184, 483	None	
	Molybdenum	2.5	2.5	Next at 1.7
	Nickel	5.8, 17.5	None	
	Titanium	36.5, 184	None	
	Vanadium	9.6	9.6	Next highest at 1.8
	Zinc	7.8U, 34.8, 137	None	
SW-Assabet-Up-DIS	Aluminum	85.4	85.4	Only hit - high DL of 15
10 Samples	Iron	627	None	
	Lead	2.2J	2.2J	Only hit - high DL of 0.45
17002 contained	Manganese	93.7	93.7	Next high 64, ave 61
only one maximum for the	Potassium	7440	None	
dissolved analysis	Thallium	0.35	0.35	Only hit - high DL of 0.086
	Uranium	0.027UJ	None	
SW-Assabett-Site-TOTAL	Nickel	5	5	Not much above next highest at 2.8
	Potassium	8190	8190	Not much above next highest at 7320
10 Samples	Uranium	0.097	None	
	Zinc	17.1	17.1	Min 7.5, next highest 10.9
	Zirconium	0.96	0.96	Only hit - Poisson UCL
SW-Assabet-Site-Dis	Magnesium	4290	4290	Next highest 4110, ave 4049
	Nickel	4.7	4.7	Next highest 3.2, ave 3.2
10 Samples	Thallium	0.39	0.39	Only hit, high DL 0.04
	Zirconium	1.1J	None	
SW-Assabett-Down-TOTAL	Aluminum	180	None	
	Barium	20.7	20.7	Min 16.8, next highest 17.9
5 Samples	Cobalt	0.81	None	
	Copper	7.1	None	
	Iron	975	None	
	Lead	2.1, 4.8	None	
	Potassium	7980	7980	Average is 7590
	Selenium	1.7	1.7	Only hit; high ND is 1.5
	Titanium	8.2	8.2	Only hit; high ND is 7
	Uranium	0.067	0.067	Ave. is 0.046; next high 0.045

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
OutliersFinal.xls
Sheet1

Page 1 of 4

Table 21
Results of Outlier Testing

Data Set	Parameter	Possible Outliers (Dixon's Test at 95%)		Comments
		Raw	Log-transformed	
SW-Assabet-Down-DIS	Calcium	21400	21400	Next highest 20400, ave 20440
5 Samples	Molybdenum	2.1	2.1	All others 2
	Selenium	<0.75U	<0.75U	1/2 DL, low hit 2.3
	Zirconium	1.4J	None	
SD-Assabett - Up	1,1,1-TCA	6.5, 28.8J	None	
	1,1-DCA	2.1	2.1	Only hit; highest ND 1.43
10 Samples	Beryllium	0.83, 50.8	50.8	50.8>two orders over next
	Cadmium	2.5	None	
	Iron	64200	None	Two remaining from sample 17001 and two
	Lead	88.1	None	from sample 17004
	Magnesium	7610J	None	
	Manganese	3010	3010	>7 times next highest
	Sodium	892J	892J	Next highest 252
	Thorium	13.8	None	
	TCE	1.7, 18.7, 46.4J	None	
	TCFM	3.6	3.6	Only hit; highest ND 1.43
	Uranium	6.1	6.1	Next highest at 2.2
SD-Assabett - Site	1,1,1-TCA	8.4	8.4	Next highest 1.6
	1,1-DCA	0.47J	None	
10 Samples	1,1-DCE	2	2	Only hit; high ND is 1.3
	Arsenic	22J	None	
	Cadmium	0.47	None	
	Calcium	3420	3420	next highest 1560; ave 1257
	Lead	251J	251J	next highest 34.3; ave 42
	Mercury	0.66J	0.66J	Next highest 0.1; ave 0.11
	Thorium	6.1J	None	
	TCE	20.7	None	Three of four from 18011 which also has maximums for 9 other parameters
SD-Assabett - Down	Arsenic	121J	121J	Next highest at 10.4
	Chromium	147J, 469J	None	
	Iron	114000J	114000J	Next highest at 12200
	Lead	327J	None	
	Manganese	564	None	Both from sample 18019 - Fe, As correlated?
	Molybdenum	8.4	None	
	Tungsten	1.9J	None	
	Zinc	260J	None	
	Zirconium	4J	4J	Next highest at 1.2; log-normal
SO-Forest-8270C	Benzo[a]anthracene	31.1J, 33.2J	31.1J, 33.2J	Only hits; ND as high as 42.9U
	Benzo[a]pyrene	<199U, 28J, 36.7J, 220	Same	Three detects only hits
Exclude SSRI17015000 NDs	Bis(2-chloroethyl)ether	<209U,<215U,324-3460	Same	Four detects only hits
14 Samples	Phenanthrene	83.2	83.2	Next highest 38.2

Table 21
Results of Outlier Testing

Data Set	Parameter	Possible Outliers (Dixon's Test at 95%)		Comments
		Raw	Log-transformed	
SO-Forest-8310	Benzo[a]anthracene	25.2J	None	
SO-Forest-Metals	Cadmium	0.1, 0.13	0.13	Only two hits, ND as high as 0.13
	Magnesium	4220	None	
15 Samples	Manganese	241	241	Next highest 133J; ave 93
	Molybdenum	1220	1220	Next highest 746; ave 587
	Nickel	14.4J	None	
	Vanadium	29.7J	None	
SD- Maynard - 8310	Fluorene	329J	None	
SD-Maynard - 8270C	Acenaphthylene	<268U	None	
	Benzo[a]anthracene	4340	None	
15 Samples	Benzo[a]pyrene	5550J	None	
	Benzo[b]fluoranthene	9000J	None	
	Benzo[ghi]perylene	2820J	None	
	Benzo[k]fluoranthene	4100J	None	
	Benzoic Acid	<5350U	None	
	Chrysene	5770	None	
	Dibenzofuran	<2680U	None	
	Fluoranthene	9660	None	
	Inden[1,2,3-cd]pyrene	2820J	None	
	Pyrene	9790	None	
SD-Maynard - Metals	Aluminum	23200	None	
	Antimony	0.66J	0.66J	Only hit - ND as high as 0.47
10 Samples	Cadmium	2.9	None	
	Potassium	<328.5U	<328.5U	1/2 detection - low hit of 1110
	Silver	0.17	0.17	Next highest hit of 0.042
	Thallium	0.23	0.23	Next highest 0.11, but DL high as 0.2
	Thorium	0.85	0.85	Low - next lowest 3.6
SW - Maynard - TOTAL	Lead	4.7	4.7	Range of remaining detects 3.9 - 3.7
5 Samples	Mercury	0.04	0.04	Only hit - ND at 0.037
	U235 - as mass	0.001	0.001	Only hit - ND at 0.001
SW - Maynard - DIS	Lead	<1UJ	<1UJ	This is 1/2 DL of 2; detects 2.2-2.3
5 Samples	Vanadium	0.86	0.86	Only hit - ND of 0.63

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\
OutliersFinal.xls
Sheet1

Page 3 of 4

Table 21
Results of Outlier Testing

Data Set	Parameter	Possible Outliers (Dixon's Test at 95%)		Comments
		Raw	Log-transformed	
SD - Conant Well Property	Barium	74.4J	74.4J	Next highest 54.2; Discard
	Lead	300, 145, 96.5J	None	
10 Samples	Nickel	9.2	9.2	This is a low outlier
	Sodium	2540	2540	Non-parametric; next highest 1170; Discard
	Zinc	78.6J	78.6J	
	Benzo(a)anthracene	140J; 2.47(ND)	140J; 2.47(ND)	Both highest and lowest; only 6 samples; Discard
	Benzo(b)fluoranthene	53.9J	53.9J	Only hit, next high is DL/2 of 25.1
	Chrysene	118J, 2.47(ND)	118J, 2.47(ND)	Highest and lowest; only 6 samples; Discard
	Fluoranthene	184	184	Next highest 72.4; Discard
	Phenanthrene	120J	None	
	Pyrene	147	147	Next highest is 76.4; Discard
PEAT - Hudson Bog	Manganese	38J	None	
	Potassium	378J, 311J	378J	Discard
11 Samples	Thallium	0.075, 0.066	None	
	Uranium	2.2, 1.7	2.2	
	Benzo(b)fluoranthene	373J	None	All hits flagged "J"
	Benzoic Acid	4520J, 3660J, 1880, 676J	4520J, 3660J, 1880	
	Butylbenzyphthalate	2390J, 940(ND)	2390J, 940(ND)	Poisson; 2390J only hit
	Chrysene	122J	None	
	Diethylphthalate	15700J, 940(ND)	15700J	Discard - extreme outlier
	Phenol	2010J	2010J, 229J	The 229J is a low outlier, next high is an ND
SD and PEAT Combined - Hudson Bog	Manganese	38J	None	
	Potassium	378J	378J	Discard - extreme outlier
15 Samples	Tungsten	1.3J	None	
	Uranium	2.2	None	
	Benzoic Acid	4520J, 3660J, 1880	4520J, 3660J	All detections are flagged "J"
	Diethylphthalate	15700, 940(ND)	15700	Discard - extreme outlier
	Phenol	2010J	None	
SW - Hudson Bog - DIS	Chromium	2.2	2.2	Next highest 1.7
	Nickel	3.1	3.1	Next highest 2.5
10 Samples	Thallium	0.39, 0.075(ND)	0.39	Poisson dist; 0.39 only hit
	Zirconium	?	?	Can't perform test; DL of 0.5 and max of 0.53
SW - Hudson Bog - TOTAL	Barium	26.4	26.4	Range of remaining detects 20.5 - 15.3
	Cadmium	0.15	0.15	Range of remaining detects 0.12 - 0.09
10 Samples	Sodium	22600, 16400	16400	Low outlier
	Thallium	0.35, 0.11	None	
	Tungsten	0.87	0.87	Poisson, only hit
	Zinc	22.5	22.5	Low outlier; next lowest 31.2

Highlighted cells indicate outliers discarded from the data set (see text section 3.4)

Table 22
Recommended Upper Limits for Background - Sediment

Parameter	Recommended Upper Limit			
	Maynard Pond	Assabet Upstream	Conant Well Property	Hudson Bog
Volatile Organic Compounds (mg/Kg)				
1,1,1-Trichloroethane	--	0.0288	--	--
1,1-Dichloroethane	--	0.00210	--	--
1,1-Dichloroethene	--	0.00750	--	--
Carbon disulfide	--	0.00320	--	--
Cis-1,2-Dichloroethene	--	0.000890	--	--
Tetrachloroethene	--	0.00520	--	--
Trichloroethene	--	0.0464	--	--
Trichlorofluoromethane	--	0.00350	--	--
Semi-volatile Organic Compounds (mg/Kg)				
Acenaphthene	0.242	--	ND	ND
Acenaphthylene	0.0947	--	ND	ND
Anthracene	0.340	--	ND	ND
Benzo[a]anthracene	4.34	--	ND	0.078
Benzo[a]pyrene	5.55	--	0.516	ND
Benzo[b]fluoranthene	9.00	--	0.417	0.373
Benzo[ghi]perylene	2.82	--	ND	ND
Benzo[k]fluoranthene	4.10	--	ND	0.077
Benzoic Acid	0.638	--	3.97	4.52
Bis(2-chloroethyl)ether	ND	ND	ND	0.231
Bis(2-Ethylhexyl)phthalate	0.627	--	0.531	ND
Butylbenzylphthalate	ND	ND	ND	1.6
Chrysene	5.77	--	0.119	0.122
Dibenz[a,h]anthracene	0.163	--	ND	ND
Dibenzofuran	0.133	--	ND	ND
Diethylphthalate	ND	ND	ND	0.521
Fluoranthene	3.66	--	0.176	0.2
Fluorene	0.365	--	ND	ND
Indeno[1,2,3-cd]pyrene	2.82	--	0.185	ND
m&p-Methylphenol	ND	ND	ND	6.96
Phenanthrene	1.72	--	0.087	0.125
Phenol	ND	ND	ND	2.01
Pyrene	3.79	--	0.192	0.179

Table 22
Recommended Upper Limits for Background - Sediment

Parameter	Recommended Upper Limit			
	Maynard Pond	*Assabet Upstream*	*Conant Well Property*	*Hudson Bog*
Metals (mg/Kg)				
Aluminum	21010	16700	27400	4982
Antimony	0.280	ND	ND	ND
Arsenic	11.8	109	9.8	4.0
Barium	54.7	81.1	54.2	46.0
Beryllium	0.630	50.8	3.90	0.54
Cadmium	2.90	2.50	0.97	0.46
Calcium	1400	6380	3156	1960
Chromium	37.5	40.6	29.7	7.09
Cobalt	5.70	30.6	4.82	1.6
Copper	30.8	46.7	23.5	10.3
Iron	18200	64200	9520	4276
Lead	242	88.1	300	55.2
Magnesium	3890	7610	2710	426
Manganese	121	1635	84.0	31.2
Mercury	0.350	0.130	0.161	0.075
Molybdenum	1.30	6.10	2.60	1.00
Nickel	21.1	29.8	17.0	5.7
Potassium	2330	4960	751	254
Selenium	ND	ND	4.20	2.1
Silver	0.170	0.300	0.159	0.140
Sodium	393	892	1170	389
Thallium	0.230	0.430	0.32	0.069
Thorium	5.70	13.8	2.34	2.54
Titanium	647	648	727	157
Tungsten	0.920	1.29	0.37	1.09
Uranium	2.50	4.50	22.6	1.89
Vanadium	35.2	53.9	28.8	12.1
Zinc	244	55.6	78.6	29.3
Zirconium	2.00	3.40	1.90	1.58

-- Not Analyzed
ND - Not Detected
mg/kg - milligrams per kilogram

Prepared by: MK
Checked by: JHP

P:\Projects\Nuclear Metals RI FS EECA\4.0 Project Deliverables\4.1 Reports\Background Assessment Spring 2005 Data\Draft Spring 2005 Bkgnd Report_12152005\Tables\Table Recommended ULs.xls\Sediment

Table 23
Recommended Upper Limits for Background - Surface Water

Parameter	Recommended Upper Limit			
	Maynard Pond	*Assabet Upstream*	*Conant Well Property*	*Hudson Bog*
Volatile Organic Compounds (ug/L)				
Methyl ethyl ketone	--	59.0	--	--
Methyl Tertbutyl Ether	--	0.330	--	--
Dissolved Metals (ug/L)				
Aluminum	ND	21.0	221	257
Arsenic	1.50	1.80	ND	ND
Barium	3.4	18.7	29.3	15.9
Beryllium	ND	ND	ND	0.123
Cadmium	ND	ND	0.031	0.081
Calcium	ND	19800	8130	3150
Chromium	0.510	ND	0.62	2.16
Cobalt	ND	0.470	1.0	1.37
Copper	ND	ND	0.62	2.2
Iron	ND	627	815	697
Lead	2.30	0.800	1.0	2.3
Magnesium	178	4760	1840	830
Manganese	18	93.7	72.9	190
Mercury	ND	0.0600	ND	0.048
Molybdenum	ND	1.70	ND	ND
Nickel	ND	3.30	2.3	2.89
Potassium	1290	7396	1200	1920
Sodium	3076	67300	83700	24600
Thallium	ND	0.195	ND	0.14
Titanium	ND	ND	1.8	3.5
Uranium	ND	0.0270	0.18	0.0259
Vanadium	0.860	0.950	ND	ND
Zinc	ND	ND	8.9	38.1
Zirconium	ND	ND	ND	0.53

-- Not Analyzed
ND - Not Detected
ug/L - micrograms per liter
Prepared by: MK
Checked by: JHP

Table 24
Recommended Upper Limits for Background - Soil

Parameter	Recommended Upper Limit
	Stow Town Forest
Semi-volatile Organic Compounds (mg/Kg)	
Benzo[a]anthracene	0.0332
Benzo[a]pyrene	0.220
Benzo[b]fluoranthene	0.0662
Benzoic Acid	0.298
Bis(2-Chloroethyl)ether	3.46
Chrysene	0.0586
Fluoranthene	0.0656
Phenanthrene	0.0832
Pyrene	0.161
Metals (mg/Kg)	
Aluminum	16500
Arsenic	13.7
Barium	26.3
Beryllium	0.460
Cadmium	0.130
Calcium	600
Chromium	21.9
Cobalt	4.30
Iron	15485
Lead	47.7
Magnesium	4220
Manganese	241
Mercury	0.0708
Molybdenum	1.22
Nickel	13.3
Potassium	1530
Silver	0.0900
Thorium	7.35
Titanium	661
Uranium	1.30
Vanadium	26.1

mg/kg - milligrams per kilogram
Prepared by: MK
Checked by: JHP

Table 25
Analytes not Detected in both Upgradient and Downgradient
Assabet River Surface Water and Sediment Samples

Analytes in Upstream Samples not in Site Samples		
	Surface water	Sediment
	Beryllium(total)	Carbon Disulfide
	Chromium(total)	Cis-1,2-DCE
	Mercury(total)	Trichlorofluoromethane
	Thallium(total)	
	Thorium(total)	
	Tungsten(total)	
Analytes in Upstream Samples not in Downstream Samples		
	Surface Water	Sediment
	Beryllium(total)	1,1,1-TCA
	Chromium(total)	1,1-DCA
	Mercury(total)	Cis-1,2-DCE
	Silver(total)	PCE
	Thorium(total)	TCE
	Titanium(total)	Trichlorofluoromethane
	Tungsten(total)	
	Cobalt(dissolved)	
	Mercury(dissolved)	
	Thallium(dissolved)	
Analytes in Site Samples not in Downstream Samples		
	Surface Water	Sediment
	TCE	1,1,1-TCA
	Thallium(total)	1,1-DCE
	Zirconium(total)	
	Mercury(dissolved)	
	Thallium(dissolved)	
Analytes in Site Samples not in Upstream Samples		
	Surface Water	Sediment
	TCE	Selenium
	Arsenic(total)	
	Zirconium(total)	
	Copper(dissolved)	
	Selenium(dissolved)	
	Zinc(dissolved)	
Analytes in Downstream Samples not in Upstream Samples		
	Surface Water	Sediment
	Arsenic(total)	Acetone
	Selenium(total)	MEK
	Copper(dissolved)	Toluene
	Selenium(dissolved)	Antimony
		Selenium
Analytes in Downstream Samples not in Site Samples		
	Surface Water	Sediment
	Selenium(total)	Antimony
	Titanium(total)	
	Cobalt(dissolved)	

Table 26
Groupwise Comparison
Assabet River Upstream with Site Surface Water

	Upstream		Site		Parametric	Result of t-Test Comp			Result of WRS Test		
	Samples	Distribution	Samples	Distribution	Dist. Match	T-value	T-critical	Different?	W	Different?	Comment
VOCs(MG/L)					See note 2	See Note 2		See note 2	See note 1		
Methyl ethyl ketone	10	Normal	10	Non-parametric					61	Yes	Site lower
Methyl Tertbutyl Ether	10	Non-parametric	10	Normal					115	No	
Trichloroethene	10	Not detected	10	Non-parametric					130	No	
Dissolved Metals (UG/L)											
Aluminum	10	Poisson	10	Normal					131.5	Yes	Site higher
Arsenic	10	Non-parametric	10	G/NP					103.5	No	
Barium	10	Normal	10	Normal	Y	2.126	2.101	Yes	78	Yes	Site lower
Calcium	10	Normal	10	Normal	Y	0.291	2.101	No	101.5	No	
Cobalt	10	Non-parametric	10	Normal					75	Yes	Site lower
Iron	10	Non-parametric	10	Non-parametric					105	No	
Lead	10	Poisson	10	Normal					143.5	Yes	Site higher
Magnesium	10	Normal	10	Normal	Y	2.231	2.101	Yes	86	No	
Manganese	10	Non-parametric	10	Non-parametric					68.5	Yes	Site lower
Mercury	10	Poisson	10	Poisson					105	No	
Molybdenum	10	Non-parametric	10	Normal					128	No	
Nickel	10	Normal	10	Non-parametric					95.5	No	
Potassium	10	Normal	10	Normal	Y	-0.858	2.101	No	114.5	No	
Selenium	10	Not detected	10	Non-parametric					123	No	
Sodium	10	Normal	10	G/NP					76	Yes	Site lower
Thallium	10	Poisson	10	Poisson					75.5	Yes	Site lower
Uranium	10	Non-parametric	10	Non-parametric					124	No	
Vanadium	10	Non-parametric	10	Not detected					103	No	
Zinc	10	Not detected	10	Non-parametric					128	No	
Zirconium	10	Not detected	10	Poisson					88	No	

Notes: 1. The critical range for the W statistic for two-sided alpha of 0.025 or one-sided alpha of 0.05 and n=10 and m=10 is 79 to 131.
  If the WRS test statistic is within this range, then the hypothesis of equal medians cannot be rejected at the 0.05 level of significance.
  A test value lower than the lower critical value indicates that the downgradient sample median was statistically lower than that of the upgradient set.
2. If the condition of equal distributions is met, a shaded box also indicates that the modified Levene Equal-Variance Test could not
  reject the hypothesis of equal variances. A simple t-test was used in cases of equal variance, and the Aspin-Welch Unequal
  Variance Test was used when the hypothesis was rejected.

Table 27
Groupwise Comparison
Assabet River Upstream to Downstream Surface Water

	Upstream		Downstream		Parametric	Result of t-Test Comp			Result of WRS Test		
	Samples	Distribution	Samples	Distribution	Dist. Match	T-value	Tcritical	Different?	W	Different?	Comment
VOCs(MG/L)					See Note 2	See Note 2		See Note 2		See Note 1	
Methyl ethyl ketone	10	Normal	5	Normal	Y	2.547	2.228	Yes	22	Yes	Down lower
Methyl Tertbutyl Ether	10	Non-parametric	5	Non-parametric					39.5	No	
Dissolved Metals (UG/L)											
Aluminum	10	Poisson	5	Normal					60	Yes	Al in only 1 of 10 Upstream
Arsenic	10	Non-parametric	5	Normal					45	No	
Barium	10	Normal	5	Normal	Y	0.0973	2.16	No	41	No	
Calcium	10	Normal	5	Normal	Y	-4.535	2.16	Yes	65	Yes	Narrow SD, means < 10% different
Cobalt	10	Non-parametric	5	Normal					58.5	Yes	
Copper	10	Not detected	5	Normal					61	Yes	Cu ND upstream
Iron	10	Non-parametric	5	Normal					40	No	
Lead	10	Poisson	5	Normal					60	Yes	Pb in only 1 of 10 Upstream
Magnesium	10	Normal	5	Normal	Y	-2.483	2.207	Yes	55	No	
Manganese	10	Non-parametric	5	Normal					56	No	
Mercury	10	Poisson	5	Not detected					37.5	No	
Molybdenum	10	Non-parametric	5	Non-parametric					65	Yes	Narrow SD, means < 25% different
Nickel	10	Normal	5	Normal	Y	-11.91	2.16	Yes	65	Yes	Narrow SD, means ~ 20% different
Potassium	10	Normal	5	Normal	Y	-6.253	2.16	Yes	65	Yes	Narrow SD, means ~ 17% different
Selenium	10	Not detected	5	Non-parametric					55	No	
Sodium	10	Normal	5	Normal	Y	-5.368	2.16	Yes	64.5	Yes	Narrow SD, means ~ 13% different
Thallium	10	Poisson	5	Not detected					44	No	
Uranium	10	Non-parametric	5	Normal					64.5	Yes	
Vanadium	10	Non-parametric	5	Not detected					39	No	
Zinc	10	Not detected	5	Non-parametric					59	Yes	Zn ND in Upstream
Zirconium	10	Not detected	5	Non-parametric					40.5	No	Zr in only 1 of 5 Downstream

Notes: 1. The critical range for the W statistic for two-sided alpha of 0.025 or one-sided alpha of 0.05 and n=10 and m=5 is 24 to 56.
If the WRS test statistic is within this range, then the hypothesis of equal medians cannot be rejected at the 0.05 level of significance.
A test value lower than the lower critical value indicates that the downgradient sample median was statistically lower than that of the upgradient set.
2. If the condition of equal distributions is met, a shaded box also indicates that the modified Levene Equal-Variance Test could not
reject the hypothesis of equal variances. A simple t-test was used in cases of equal variance, and the Aspin-Welch Unequal
Variance Test was used when the hypothesis was rejected.

Table 28
Groupwise Comparison
Assabet River Upstream with Site Sediments

	Upstream		Site		Parametric	Result of t-Test Comp			Result of WRS Test		
	Samples	Distribution	Samples	Distribution	Dist. Match	T-value	Tcritical	Different?	W	Different?	Comment
VOCs (UG/KG)					See Note 2	See Note 2		See Note 2		See Note 2	
1,1,1-Trichloroethane	10	Non-parametric	10	Non-parametric					109	No	
1,1-Dichloroethane	10	Poisson	10	Poisson					92	No	
1,1-Dichloroethene	10	Poisson	10	Poisson					95	No	
Carbon disulfide	10	Poisson	10	Not detected							
Cis-1,2-Dichloroethene	10	Poisson	10	Not detected							
Tetrachloroethene	10	Non-parametric	10	Non-parametric					87	No	
Trichloroethene	10	Non-parametric	10	G/NP					82	No	
Trichlorofluoromethane	10	Poisson	10	Not detected							
Metals (MG/KG)											
Aluminum	10	Normal	10	Normal	Y	2.059	2.101	No	80	No	
Arsenic	10	Non-parametric	10	G/NP					85	No	
Barium	10	Normal	10	Normal	Y	1.61	2.125	No	87	No	
Beryllium	10	Non-parametric	10	Normal					96.5	No	
Cadmium	10	G/NP	10	G/NP					71	Yes	Site lower
Calcium	10	G/NP	10	G/NP					100	No	
Chromium	10	Normal	10	Normal	Y	-1.248	2.101	No	117	No	
Cobalt	10	G/NP	10	Normal					101.5	No	
Copper	10	Normal	10	Normal	Y	2.931	2.172	Yes	75	Yes	Site lower
Iron	10	G/NP	10	Normal					93	No	
Lead	10	G/NP	10	Lognormal					93	No	
Magnesium	10	G/NP	10	Normal					100	No	
Manganese	10	Lognormal	10	Normal					101	No	
Mercury	10	Normal	10	Lognormal					106	No	
Molybdenum	10	Non-parametric	10	G/NP					91	No	
Nickel	10	Normal	10	Normal	Y	0.834	2.101	No	98.5	No	
Potassium	10	G/NP	10	Normal					99	No	
Selenium	10	Not detected	10	Poisson					95.5	No	
Silver	10	Normal	10	Normal	Y	1.063	2.101	No	90.5	No	
Sodium	10	G/NP	10	Normal					106	No	
Thallium	10	G/NP	10	Normal					99	No	
Thorium	10	G/NP	10	Normal					85	No	
Titanium	10	Normal	10	Normal	Y	0.353	2.101	No	103	No	
Tungsten	10	Normal	10	Normal	Y	0.562	2.101	No			
Uranium	10	Lognormal	10	Normal					94	No	
Uranium (no 17004)	9	Normal	10	Normal	Y	0.089	2.11	No	96	No	
Vanadium	10	G/NP	10	Normal					104.5	No	
Zinc	10	Normal	10	Normal	Y	1.353	2.101	No	88	No	
Zirconium	10	Normal	10	Normal	Y	1.666	2.101	No	82.5	No	

Notes: 1. The critical range for the W statistic for two-sided alpha of 0.025 or one-sided alpha of 0.05 and n=10 and m=10 is 79 to 131.
      For n=9 and m=10, the critical range is 66 to 114.
      If the WRS test statistic is within this range, then the hypothesis of equal medians cannot be rejected at the 0.05 level of significance.
      A test value lower than the lower critical value indicates that the downgradient sample median was statistically lower than that of the upgradient set.
   2. If the condition of equal distributions is met, a shaded box also indicates that the modified Levene Equal-Variance Test could not
      reject the hypothesis of equal variances. A simple t-test was used in cases of equal variance, and the Aspin-Welch Unequal
      Variance Test was used when the hypothesis was rejected.

	Upstream		Site		Parametric	Result of t-Test Comp			Result of WRS Test		
	Samples	Distribution	Samples	Distribution	Dist. Match	T-value	Tcritical	Different?	W	Different?	Comment
VOCs (UG/KG)					See Note 2	See Note 2		See Note 2		See Note 1	
1,1,1-Trichloroethane	10	Non-parametric	5	Not detected							
1,1-Dichloroethane	10	Poisson	5	Not detected							
1,1-Dichloroethene	10	Poisson	5	Non-parametric					48	No	
Acetone	10	Not detected	5	Lognormal					60	Yes	Down higher
Carbon disulfide	10	Poisson	5	Non-parametric					60	Yes	Down higher
Cis-1,2-Dichloroethene	10	Poisson	5	Not detected							
Tetrachloroethene	10	Non-parametric	5	Not detected							
Trichloroethene	10	Non-parametric	5	Not detected							
Trichlorofluoromethane	10	Poisson	5	Not detected					55	No	
Methyl ethyl ketone	10	Not detected	5	Normal					56.5	Yes	Down higher
Toluene	10	Not detected	5	Non-parametric							
Metals (MG/KG)											
Aluminum	10	Normal	5	Non-parametric					36	No	
Antimony	10	Not detected	5	Normal					45	No	
Arsenic	10	Non-parametric	5	Lognormal					40	No	
Barium	10	Normal	5	Normal	Y	-0.0017	2.16	No	40	No	
Beryllium	10	Non-parametric	5	Normal					39	No	
Cadmium	10	G/NP	5	Normal					39	No	
Calcium	10	G/NP	5	Normal					38	No	
Chromium	10	Normal	5	G/NP					49	No	
Cobalt	10	G/NP	5	Normal					45	No	
Copper	10	Normal	5	G/NP					39	No	
Iron	10	G/NP	5	Lognormal					35	No	
Lead	10	G/NP	5	G/NP					46	No	
Magnesium	10	G/NP	5	Normal					28	No	
Manganese	10	Lognormal	5	Normal					41	No	
Mercury	10	Normal	5	Normal	Y	-1.729	2.715	No	52.5	No	
Molybdenum	10	Non-parametric	5	G/NP					47	No	
Nickel	10	Normal	5	Normal	Y	0.5667	2.16	No	34	No	
Potassium	10	G/NP	5	Normal					33	No	
Selenium	10	Not detected	5	Normal					61	Yes	Se ND in Upstream
Silver	10	Normal	5	Normal	Y	-1.409	2.16	No	45.5	No	
Sodium	10	G/NP	5	Normal					43	No	
Thallium	10	G/NP	5	Normal					38	No	
Thorium	10	G/NP	5	Normal					25.5	No	
Titanium	10	Normal	5	Normal	Y	0.995	2.16	No	33	No	
Tungsten	10	Normal	5	Normal	Y	-1.368	2.16	No	49	No	
Uranium	10	Lognormal	5	Normal					27.5	No	
Uranium (no 17004)	9	Normal	5	Normal	Y	1.323	2.179	No	27.5	No	
Vanadium	10	G/NP	5	Normal					43	No	
Zinc	10	Normal	5	Normal	Y	-1.227	2.16	No	40	No	
Zirconium	10	Normal	5	Lognormal					32	No	

Notes: 1. The critical range for the W statistic for two-sided alpha of 0.025 or one-sided alpha of 0.05 and n=10 and m=5 is 24 to 56.
   For n=9 and m=5, the critical range is 22 to 53.
   If the WRS test statistic is within this range, then the hypothesis of equal medians cannot be rejected at the 0.05 level of significance.
   A test value lower than the lower critical value indicates that the downgradient sample median was statistically lower than that of the upgradient set.
2. If the condition of equal distributions is met, a shaded box also indicates that the modified Levene Equal-Variance Test could not
   reject the hypothesis of equal variances. A simple t-test was used in cases of equal variance, and the Aspin-Welch Unequal
   Variance Test was used when the hypothesis was rejected.

Table 30
Comparison to Recommended Upper Limits
Assabet River Site Surface Water

Parameter	Recommended Upstream UL	SWRI18008000 11/3/2004 9:40:00 AM	SWRI18009000 11/3/2004 9:15:00 AM	SWRI18010000 11/3/2004 8:45:00 AM	SWRI18011000 11/2/2004 1:30:00 PM	SWRI18012000 11/2/2004 12:50:00 PM	SWRI18013000 11/2/2004 12:20:00 PM	SWRI18014000 11/2/2004 11:30:00 AM	SWRI18015000 11/2/2004 10:40:00 AM	SWRI18016000 11/2/2004 10:01:00 AM	SWRI18017000 11/2/2004 9:23:00 AM	Result of WRS Group Comparison
VOCs (MG/L)												See Note 2
Methyl ethyl ketone	0.059	0.001 U	0.018 U	0.012 U	0.0035	0.0011 U	0.0011	0.00033 J	0.001 U	0.001 U	0.0028	
Methyl Tertbutyl Ether	0.00033	0.0005 U	0.0005 U	0.0005 U	0.00027 J	0.00027 J	0.0003 J	0.00026 J	0.00028 J	0.00029 J	0.00028 J	
Trichloroethene	ND	0.0005 U	0.00026 J	0.0005 U	0.00026 J	0.0003 J	0.00032 J	0.0005 U	0.00026 J	0.0005 U	0.0005 U	*
Dissolved Metals (UG/L)												
Aluminum	21	4.7	7	6	6.4	17.3	16.8	21.6	4.9	12	10.1	Yes
Arsenic	1.8	1.3	0.96 U	1.5	1.5	1.5	0.96 U	0.96	1.6	0.96 U	1.2	
Barium	18.7	17	17.7	17.2	16.2	16.4	17	16.9	16.4	17	17.6	
Calcium	19800	18200	18200	18100	18700	19100	19900	19200	18600	19100	19600	
Copper	ND	2.4	2.4	2.2	2.3	2.3	2.6	2.5	2.2	2.3	2.2	*
Iron	627	223	227	208	297	293	288	327	219	221	230	
Lead	0.8	0.38	0.25	0.23	0.39	0.41	0.46	0.49	0.21	0.33	0.3	Yes
Magnesium	4760	3950	3970	3950	4120	4290	4040	4060	4110	4000	4000	
Manganese	93.7	59.4	56.3	54.8	46.5	47.6	48.4	46.1	47.8	48.2	48.4	
Mercury	0.06	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.21	0.037 U	0.037 U	0.037 U	0.037 U	
Molybdenum	1.7	1.6	1.6	1.6	1.8	1.8	2	1.9	2.1	1.9	2	
Nickel	3.3	3	3.1	3.1	2.9	3	3.2	3	4.7	3.2	3.1	
Potassium	7396	6430	6920	6400	6630	6900	7310	7290	6840	6880	7260	
Selenium	ND	2.8 U	2.9 U	2.4 U	2.7 J	1.5 UJ	1.5 UJ	1.9 J	3.3 U	1.5 J	2 J	*
Sodium	67300	57300	58800	59300	57300	57000	61500	56300	58100	56900	64400	
Thallium	0.195	0.015 U	0.013 U	0.013 U	0.04 U	0.029 U	0.02 U	0.013 U	0.39	0.013 U	0.013 U	
Uranium	0.027	0.003 UJ	0.003 UJ	0.003 UJ	0.026	0.036	0.036	0.034	0.003 UJ	0.03	0.032	
Zinc	ND	7.7 U	6.9 U	6.6 U	8.3 U	12.7	14	11.8	6 U	10.4	9 U	*
Zirconium	ND	0.099 U	0.095 U	0.072 U	0.29 UJ	0.25 UJ	0.18 UJ	0.12 UJ	1.1 U	0.59 UJ	1.1 J	*

Note: 1. Exceedance of the recommended UL in a single sample is indicated by shading the value.

2. Yes indicates WRS Test result indicated downgradient sample exceeded upgradient as a group.

* indicates a significant higher difference due to non-detect in the background sample set.

Table 31
Comparison to Recommended Upper Limits
Assabet River Downstream Surface Water

Parameter	Recommended Upstream UL	SWRI18018000 11/1/2004 2:25:00 PM	SWRI18019000 11/1/2004 3:17:00 PM	SWRI18020000 11/1/2004 3:53:00 PM	SWRI18021000 11/1/2004 4:25:00 PM	SWRI18022000 11/1/2004 4:44:00 PM	Result of WRS Group Comparison
VOCs (MG/L)							See Note 2
Methyl ethyl ketone	0.059	0.0028	0.0059	0.0052	0.0023	0.011	
Methyl Tertbutyl Ether	0.00033	0.00027 J	0.00025 J	0.00027 J	0.0005 U	0.0005 U	
Dissolved Metals (UG/L)							
Aluminum	21	15.1	13	14.6	12.6	15	Yes
Arsenic	1.8	1	0.96 U	2.2	1.9	0.98	
Barium	18.7	17.8	17.2	17.4	17.2	17.8	
Calcium	19800	21400	20200	20300	19900	20400	Yes
Cobalt	0.47	0.38	0.41	0.38	0.47	0.49	Yes
Copper	ND	2.6	2.4	2.9	2.3	2.5	*
Iron	627	299	171	262	233	392	
Lead	0.8	0.42	0.23	0.39	0.27	0.44	Yes
Magnesium	4760	4580	4540	4660	4500	4470	
Manganese	93.7	66.6	64.1	55.5	91.5	106	
Molybdenum	1.7	2.1	2	2	2	2	Yes
Nickel	3.3	3.8	3.7	3.7	3.8	3.9	Yes
Potassium	7396	8340	7970	8200	7570	7630	Yes
Selenium	ND	1.5 UJ	2.6 J	2.3 J	2.3 J	2.4 J	*
Sodium	67300	67300	69500	70300	73100	71800	Yes
Uranium	0.027	0.035	0.028	0.03	0.027	0.03	Yes
Zinc	ND	11	7.9 U	10.8	9.5 U	8.2 U	*
Zirconium	ND	0.3 UJ	1.4 J	0.51 UJ	0.28 UJ	0.15 UJ	*

Note: 1. Exceedance of the recommended UL in a single sample is indicated by shading the value.
2. Yes indicates WRS Test result indicated downgradient sample exceeded upgradient as a group.
* indicates a significant higher difference due to non-detect in the background sample set.

Table 32
Comparison to Recommended Upper Limits
Assabet River Site Sediments

Parameter	Recommended Upstream UL	SDRI18008000 11/3/2004 9:40:00 AM	SDRI18009000 11/3/2004 9:15:00 AM	SDRI18010000 11/3/2004 8:45:00 AM	SDRI18011000 11/2/2004 1:30:00 PM	SDRI18012000 11/2/2004 12:50:00 PM	SDRI18013000 11/2/2004 12:20:00 PM	SDRI18014000 11/2/2004 11:55:00 AM	SDRI18015000 11/2/2004 11:00:00 AM	SDRI18016000 11/2/2004 10:15:00 AM	SDRI18017000 11/2/2004 9:31:00 AM	Result of WRS Group Comparison
VOCs (UG/KG)												See Note 2
1,1,1-Trichloroethane	28.8	1.6	1.4	1.6	8.4	1.06 U	1.09 U	0.928 U	0.799 U	1 U	0.923 U	
1,1-Dichloroethane	2.1	0.47 J	1.12 U	1.26 U	0.855 U	1.06 U	1.09 U	0.928 U	0.799 U	1 U	0.923 U	
1,1-Dichloroethene	7.5	0.812 U	1.12 U	1.3 U	2	1.06 U	1.09 U	0.928 U	0.799 U	1 U	0.923 U	
Tetrachloroethene	5.2	0.57 J	0.52 J	0.55 J	5.6	9.3	9.5	0.928 U	0.44 J	1 U	0.923 U	
Trichloroethene	46.4	3.7	3.2	2.6	20.7	2.3	2.5	0.928 U	0.799 U	1 U	0.923 U	
Metals (MG/KG)												
Aluminum	16700	10000	4930	5830	9010 J	5300 J	3310 J	8660 J	4780 J	4840 J	7160 J	
Arsenic	109	6.3	3.2	4	11 J	7.4 J	22 J	10.9 J	2.6 J	2.5 J	4.4 J	
Barium	81.1	27.7	23.6	31.8	37.1 J	18.2 J	20 J	45.4 J	21.3 J	12.6 J	26.5 J	
Beryllium	50.8	0.31	0.2	0.22	0.33	0.23	0.24	0.42	0.19	0.15	0.3	
Cadmium	2.5	0.11	0.096	0.12	0.18 J	0.11	0.22	0.47	0.073 J	0.054	0.1	
Calcium	6380	868 J	834 J	1090 J	1290 J	1140	3420	1560	995 J	550	822	
Chromium	40.6	26	23.7	56.9	58.5 J	21.4	15.7	25.9	31.8 J	13.4	36	
Cobalt	30.6	5.5	4.4	5.9	8.5	4.4 J	5.1 J	12.3 J	3	2.2 J	4.2 J	
Copper	46.7	12.7 J	17.6 J	18.1 J	22.5 J	10.2 J	10.5 J	8.7 J	6.8 J	4.7 J	11 J	
Iron	64200	13100	9530	10900	14300 J	8930	11500	16300	7200 J	7700 J	9770	
Lead	88.1	13.1	43.2	34.3	251 J	14.9 J	12 J	11.5 J	19.2 J	5 J	12.2 J	
Magnesium	7610	3780	2030	2500	3630 J	1690 J	1340 J	2530 J	2380 J	2390 J	3700 J	
Manganese	1635	129	191	200	400	145	287	340	106	90.8	194	
Mercury	0.13	0.037 J	0.09 J	0.067 J	0.66 J	0.1	0.081	0.024	0.031 J	0.0071	0.037	
Molybdenum	6.1	0.34	0.67	0.47	0.71	2.7 J	4.5 J	1.9 J	0.15	0.18 J	0.49 J	
Nickel	29.8	17.1 J	9.8 J	11.1 J	19.2	13.2 J	10.8 J	20.7 J	9.1	8.3 J	14.2 J	
Potassium	4960	1290 J	953 J	1000 J	1150 J	256 J	364 J	555 J	1020 J	534 J	1130 J	
Selenium	ND	0.76 U	0.88 U	0.81 U	0.95	1.3 U	0.47 U	1.2 U	0.355 U	0.65 U	0.8 U	*
Silver	0.3	0.045	0.15	0.3	0.13 J	0.12	0.078	0.062	0.037 J	0.022	0.099	
Sodium	892	68.6	105	120	137	107 J	90.7 J	131 J	99.2	92.2 J	151 J	
Thallium	0.43	0.12	0.078	0.087	0.12	0.072	0.055	0.16	0.11	0.055	0.071	
Thorium	13.8	4.1	3.1	2.6	3.1	6.1 J	2.2 J	4.2 J	3.6	3.8 J	3 J	
Titanium	648	489	320	367	545 J	289 J	215 J	421 J	330 J	188 J	393 J	
Tungsten	1.29	0.2 U	1	1.2	0.92 J	0.48 J	0.93 J	0.51 J	0.24 J	0.31 J	0.44 J	
Uranium	6.1	1.1	0.76	0.66	1.1	2.1	1.7	2.5	0.81	0.83	1.4	
Uranium (no 17004)	2.2	1.1	0.76	0.66	1.1	2.1	1.7	2.5	0.81	0.83	1.4	
Vanadium	53.9	19.3 J	12 J	15.1 J	22.5 J	12.5 J	13.6 J	17.9 J	11.5 J	10.1 J	15.7 J	
Zinc	55.6	38.5	40	51.4	52.7 J	24 J	34.4 J	43.4 J	22.7 J	14.3 J	22 J	
Zirconium	3.4	1.6 J	1.4 J	1.6 J	1.4 J	0.87	0.96	2.1	2.4 J	1.5	1.9	

Note: 1. Exceedance of the recommended UL in a single sample is indicated by shading the value.
2. Yes indicates WRS Test result indicated downgradient sample exceeded upgradient as a group.
* indicates a significant higher difference due to non-detect in the background sample set.

Table 33
Comparison to Recommended Upper Limits
Assabet River Downstream Sediments

Parameter	Recommended Upstream UL	SDRI18018000 11/1/2004 2:43:00 PM	SDRI18019000 11/1/2004 3:17:00 PM	SDRI18020000 11/1/2004 4:07:00 PM	SDRI18021000 11/1/2004 4:07:00 PM	SDRI18022000 11/1/2004 4:44:00 PM	Result of WRS Group Comparison
VOCs (UG/KG)							
1,1-Dichloroethene	7.5	0.8 J	0.976 U	1.49 U	1.63 UJ	2.17 U	
Acetone	ND	5.9 J	20.2	52.4 J	214 J	145	*
Carbon disulfide	3.2	4.1 J	4.88 UJ	7.43 U	7.8 J	10.8 UJ	
Methyl ethyl ketone	ND	6.55 U	4.88 U	11.3 J	45.8 J	28.6	*
Toluene	ND	1.31 U	0.976 U	1.49 U	0.77 J	2.17 U	*
Metals (MG/KG)							
Aluminum	16700	3130 J	7210 J	7380 J	7390 J	3760 J	
Antimony	ND	0.082 UJ	0.17 J	0.21 J	0.22 J	0.0509 UJ	*
Arsenic	109	2.9 J	121 J	10.4 J	8.5 J	3 J	
Barium	81.1	19.1 J	35 J	73.9 J	52.2 J	26.2 J	
Beryllium	50.8	0.14	0.6	0.33	0.35	0.21	
Cadmium	2.5	0.11 J	0.15 J	1.1 J	0.59 J	0.23 J	
Calcium	6380	1640 J	534 J	1260 J	1760 J	1150 J	
Chromium	40.6	21.6 J	17.1 J	469 J	147 J	24.2 J	
Cobalt	30.6	3.6	16.4	10	14.2	3.9	
Copper	46.7	12 J	5.4 J	72.2 J	73.8 J	10.9 J	
Iron	64200	5890 J	114000 J	9510 J	12200 J	4690 J	
Lead	88.1	19 J	5.2 J	327 J	93.2 J	29.2 J	
Magnesium	7610	1160 J	2050 J	1970 J	2640 J	1060 J	
Manganese	1635	83.4	564	230	242	191	
Mercury	0.13	0.11 J	0.019 J	0.35 J	0.39 J	0.086 J	
Molybdenum	6.1	0.56	8.4	1.3	2	0.77	
Nickel	29.8	6.1	12.4	14.6	26.7	6.4	
Potassium	4960	428 J	1040 J	689 J	733 J	380 J	
Selenium	ND	0.88	0.59	1.1	1.5	1.4	*
Silver	0.3	0.11 J	0.057 J	0.51 J	0.57 J	0.099 J	
Sodium	892	156	73	128	251	191	
Thallium	0.43	0.05	0.18	0.15	0.17	0.078	
Thorium	13.8	1.8	3.5	4.5	3.5	1.4	
Titanium	648	190 J	328 J	322 J	438 J	207 J	
Tungsten	1.29	0.59 J	0.88 J	1 J	1.9 J	0.62 J	
Uranium	6.1	0.48	1.2	1.3	1.1	0.91	
Uranium (no 17004)	2.2	0.48	1.2	1.3	1.1	0.91	
Vanadium	53.9	7.6 J	17.6 J	50 J	25.5 J	8.1 J	
Zinc	55.6	27.8 J	54.2 J	260 J	110 J	26.4 J	
Zirconium	3.4	1 J	1.2 J	4 J	0.99 J	0.72 J	

Note: 1. Exceedance of the recommended UL in a single sample is indicated by shading the value.
2. Yes indicates WRS Test result indicated downgradient sample exceeded upgradient as a group.
* indicates a significant higher difference due to non-detect in the background sample set.

APPENDIX A

**TECHNICAL MEMORANUDM – WETLAND DELINEATION AND
IDENTIFICATION OF BACKGROUND SAMPLING AREAS**

TECHNICAL MEMORANDUM

**WETLAND DELINEATION AND IDENTIFICATION OF
BACKGROUND SAMPLING AREAS**

**NUCLEAR METALS SITE
CONCORD, MASSACHUSETTS**

On May 20 and 21, 2004, MACTEC Engineering and Consulting, Inc. (MACTEC) performed a qualitative ecological assessment of habitat areas at the Nuclear Metals, Inc. Site (Site) at 2229 Main Street in Concord, Massachusetts (Figure 1) and delineated a portion of the wetland boundary along the on-site Cooling Water Recharge Pond. Candidate background locations for on-site wetland and upland areas were identified using available public information, and field reconnaissances of these areas were conducted by MACTEC personnel on May 24 and 27 and June 2, 9, and 15, 2004. This memorandum summarizes the tasks conducted and information collected as part of these field activities and provides an assessment of the candidate background locations.

1.0   SCOPE OF WORK

The primary objective of this Scope of Work was to:

- delineate the wetland boundary along the southern portion of the Cooling Water Recharge Pond;
- perform qualitative ecological assessment for on-site wetland areas and terrestrial habitats; and
- identify and assess potential background reference locations.

Each of these tasks are described below.

2.0   WETLAND DELINEATION - COOLING WATER RECHARGE POND

MACTEC delineated the wetland boundary along the southern portion of the on-site Cooling Water Recharge Pond on May 20, 2004. Wetland flags were placed along the portion of the wetland boundary located south of the cooling water discharge to the pond. Wetland flags were labeled WL100 through WL107 along approximately 50 linear feet of shoreline at the pond.. This delineation was required prior to drum removal activities from the adjacent Drum Burial Area (AOI 2). The delineation was conducted in accordance with Massachusetts Wetland Protection Act Regulations (310 Code of Massachusetts Regulations 10.55), following guidelines described in the Massachusetts Department of Environmental Protection (MADEP) handbook entitled *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (Jackson, 1995). The wetland line was demarcated based primarily on hydrology,

including water marks and breaks in slope, and to a lesser extent on wetland vegetation, which, when present, was generally restricted to the shoreline of the pond.

3.0   SITE QUALITATIVE ECOLOGICAL ASSESSMENT

The qualitative ecological assessment was performed on May 20 and 21, 2004, and involved an ecological characterization of each on-site wetland area, including documentation of vegetative species and signs of wildlife. Areas of the Site providing terrestrial habitat were also assessed. The ecological assessment was performed as part of the problem formulation step of the Screening Level Ecological Risk Assessment (SLERA; a component of the Remedial Investigation/Feasibility Study [RI/FS]). The wetland and terrestrial habitat areas of the Site were characterized in order to identify appropriate ecological receptors and exposure pathways. This information is necessary for the SLERA, and is necessary to identify background locations with similar physical and ecological attributes.

3.1   WETLAND AREAS

The following wetland areas were investigated as part of the qualitative ecological assessment: Cooling Water Recharge Pond (Area of Interest [AOI] 4), Northeast Wetland (AOI 10), Sphagnum Bog (AOI 6), and areas in the vicinity of the Assabet River receiving surface water discharge from the Site (AOIs 9 and 18). These areas are discussed in the following sections.

Cooling Water Recharge Pond (AOI 4)

The Cooling Water Recharge Pond is a roughly oval-shaped permanent water body with no outlets (Figure 2). It occupies approximately 0.7 acre and is classified under the National Wetlands Inventory (NWI) nomenclature (Cowardin et al, 1979) as a palustrine, unconsolidated bottom, permanently flooded, excavated area (PUBHx). Soils in the vicinity of the Cooling Water Recharge Pond have been mapped by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service as Hinckley loamy sand, with a 25 to 35% slope (Soil No. 35E).

The Cooling Water Recharge Pond is located in the central portion of the Site. A discharge outfall from the Holding Basin (AOI 1) is located to the south of the pond. This outfall discharges any storm water that collects on the temporary impermeable cover that was installed over the basin in 2002. A separate discharge pipe is located along the southwestern portion of the pond. At the time of the on-site reconnaissance, a steady flow of clear water was observed discharging from the pipe. This pipe reportedly discharges non-contact cooling water and storm water directed from various roof drains at the facility. Topography slopes gently to the water's edge in areas south and southeast of the pond and is moderately to steeply sloping in surrounding upland areas located north, northeast and west of the pond. An approximately 15-foot high gabion retaining wall is located north of the pond. Water in the pond was observed to be green-tinted

from apparent algal growth. Flocculent material was observed on submerged objects in the pond. Maximum water depths in the pond were difficult to estimate but appeared to be at least 4 feet in the southern portion of the pond, with greater depths occurring in the northern portion of the pond (the water depths will be characterized during the RI field investigation).

Minimal vegetation was observed in the pond, including approximately two willow (*Salix* sp.) shrubs, which were growing in areas of shallow water. Vegetation growing along the shores of the pond consisted mostly of bindweed (*Polygonum* sp.), with scattered individuals of smartweed (*Polygonum* sp.). A heavy leaf litter was observed on the ground surface in upland areas near the pond. Upland vegetation surrounding the pond was dominated by a canopy of red oak (*Quercus rubra*), eastern white pine (*Pinus strobus*), red maple (*Acer rubrum*), and white oak (*Quercus alba*), with an understory of black birch (*Betula lenta*), red maple, and eastern hemlock (*Tsuga canadensis*); a shrub layer dominated by black birch and glossy buckthorn (*Rhamnus frangula*); and a groundcover dominated by Virginia creeper (*Parthenocissus quinquefolia*), Canada mayflower (*Maianthemum canadense*), and seedlings of maple-leaved viburnum (*Viburnum acerifolium*). A complete list of vegetative species observed in or near the Cooling Water Recharge Pond is provided in Table 1.

Numerous bullfrogs (*Rana catesbeiana*) were observed and heard chorusing in the pond. Other wildlife observed in the pond included an eastern garter snake (*Thamnophis sirtalis sirtalis*), and aquatic invertebrates, including water boatmen and whirligig beetles.

Northeast Wetland (AOI 10)

The Northeast Wetland is a seasonally flooded isolated wetland, which extends in a northeast/southwest direction and occupies approximately 0.8 acre. This wetland has a relatively open canopy and is located in the northeastern portion of the Site, immediately south/southeast of Main Street. The NWI classifies the Northeast Wetland as a palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded/saturated area (PSS1E). Soils in the Northeast Wetland are mapped as Swansea muck (Soil No. 45).

At the time of the May 20, 2004 on-site reconnaissance, the northeastern portion of the wetland contained standing water (Figure 3). The standing water occupied an area of approximately 15 by 40 feet and had a maximum depth of approximately 1.5 feet. Numerous wood frog (*Rana sylvatica*) tadpoles were observed within this flooded area. The wood frog is an obligate vernal pool species; therefore, this flooded area meets the criteria for certification as a vernal pool. No herbaceous emergent vegetation was observed in the area of standing water. Scattered glossy buckthorn and American elm (*Ulmus americana*) shrubs were observed along the edges of the flooded area. On June 15, 2004, this area was observed to be completely dry.

On May 20, 2004, the southwestern portion of the wetland contained saturated soils but no standing water (Figure 4).   The center of this area contains primarily herbaceous vegetation, including false nettle (*Boehmeria cylindrica*), purple loosestrife (*Lythrum*

APPENDIX A

**TECHNICAL MEMORANUDM – WETLAND DELINEATION AND
IDENTIFICATION OF BACKGROUND SAMPLING AREAS**

salicaria), and sedges (*Carex* sp.). Clumps of highbush blueberry (*Vaccinium corymbosum*) and red maple shrubs are scattered throughout. A fawn was observed in this area, as well as deer tracks and grazed plants. On June 15, 2004, soils in this area were relatively dry.

Fallen branches and logs were present through the northeast wetland. Vegetation located along the edges of the wetland is generally dominated by a canopy of red maple and red oak; with an understory of red maple, American elm, and eastern hemlock; and a shrub layer of highbush blueberry, red maple, and American elm, intertangled with grape (*Vitis* sp.). Groundcover species observed along the edges of the wetland include jewelweed (*Impatiens capensis*), sensitive fern (*Onoclea sensibilis*), and sedges. A complete list of plant species observed in the Northeast Wetland is provided in Table 2.

Sphagnum Bog (AOI 6)

The Sphagnum Bog is located in the eastern portion the Site, immediately north of the Old Landfill (AOI 3) (Figure 5). It is roughly square-shaped with a triangular projection along its northern side and occupies approximately 3.5 acres. Topography is moderately sloping to the bog from the south and west. Topography slopes gently towards the bog in areas to the north and east. The NWI classifies the Sphagnum Bog as palustrine, scrub-shrub, broad-leaved evergreen, saturated, and acidic (PSS3Ba). Soils in the bog are mapped as Freetown muck, ponded (Soil No. 99).

At the time of the reconnaissance, standing water was present along the entire perimeter of the bog. Immediately inward of and overlapping the area of the standing water is an area containing tall shrubs, including highbush blueberry, red maple shrubs, and black chokeberry (*Photinia melanocarpa*). Clumps of sphagnum moss (*Sphagnum* sp.) were observed among the shrubs. Inward of the tall shrubs, and within the central portion of the bog is an area of low vegetation. This area contains extensive sphagnum mats with low shrubs including leatherleaf (*Chamaedaphne calyculata*) and rhodora (*Rhododendron canadense*). Scattered throughout this central area are occasional shrubs and saplings of red maple, eastern white pine, and larch (*Larix laricina*).

Movements, suggestive of tadpoles, were observed in the water along the western perimeter of the bog. Metal debris was observed protruding from the embankment west of the bog, approximately 30 feet north of the discharge pipe in the cooling water discharge pond. Occasional snags were observed along the bog perimeter. Cavities characteristic of woodpecker activity were observed in snags and trees. A fawn was observed along the southeastern edge of the bog.

Heavy leaf litter was observed in upland areas surrounding the bog. Leaf litter was also observed in the water along the perimeter. Plant species observed growing in upland areas surrounding the bog include eastern hemlock, red maple, and eastern white pine in the canopy; black birch and red maple in the understory; and dangleberry (*Gaylussacia frondosa*), black birch, and gray birch (*Betula populifolia*) in the shrub layer. Virtually no groundcover was observed in the surrounding upland areas.

A complete list of plant species observed in areas within and surrounding the Sphagnum Bog is provided in Table 3. MACTEC personnel generated this species list from walking along the bog perimeter; since interior portions of the bog were not accessed, it is likely that additional species may be present. These will be characterized during the RI field program.

Pavement Drain Outfall (AOI 9), Assabet River (AOI 18) and Associated Wetland Area

MACTEC personnel observed the Pavement Drain Outfall area (AOI 9) located north of Main Street (Figure 6). This AOI includes an area of rip-rap, located south of the road, opposite the entrance to the Nuclear Metals Facility and an approximately 3-foot diameter culvert, which extends beneath the road. The rip-rap is approximately 30 feet long and extends down a slope, south from the road. Soils in the vicinity are mapped as Hinckley loamy sand, 25 to 35% slopes (Soil No. 35E). Vegetation along the slope is dominated by a canopy of red maple, with some American elm and red oak. Species present in the shrub layer include glossy buckthorn, silky dogwood (*Cornus amomum*), Japanese barberry (*Berberis thunbergii*), and Morrow's honeysuckle (*Lonicera morrowii*). Groundcover species observed included wood fern (*Dryopteris* sp.), skunk cabbage (*Symplocarpus foetidus*), jewelweed, Virginia creeper, and Jack-in-the-pulpit (*Arisaema triphyllum*).

North of the area of rip-rap is an emergent wetland dominated by herbaceous vegetation including tussock sedge (*Carex stricta*), *Carex crinita*, cattail (*Typha latifolia*), false nettle, sensitive fern, arrow arum (*Peltandra virginica*), purple loosestrife, Jack-in-the-pulpit, enchanter's nightshade (*Circaea quadrisulcata*), wild oats (*Uvularia sessilifolia*), wood fern, and deer-tongue grass (*Panicum cladestinum*) (Figure 7). A few shrubs were observed in this area, including multiflora rose (*Rosa multiflora*), elderberry (*Sambucus canadensis*), black cherry (*Prunus serotina*), American elm, glossy buckthorn, poison ivy (*Toxicodendron radicans*), and Virginia creeper. Red maple trees were observed along the edges of the wetland.

The emergent wetland extends to the southern bank of the Assabet River. Soils immediately south of the river at this location and in the surrounding wetland area are mapped as Rippowam fine sandy loam (Soil No. 43). North of the Nuclear Metals Facility, the Assabet River is approximately 50 feet wide (Figure 8). Flow was observed to occur to the east at approximately 1 foot per second. Raccoon (*Procyon lotor*) prints were observed along the southern riverbank. Along this portion of the river, red maple is dominant in the canopy. Species present in the shrub layer include glossy buckthorn, Japanese barberry, black cherry, and Morrow's honeysuckle. Virginia creeper and seedlings of American elm were observed in the groundcover.

3.2   UPLAND AREAS

The following on-site upland areas were investigated: surface soils in the northwestern and southwestern portions of the Site (AOI 14), Former Waste Storage Area (AOI 7), Sweepings and Fill Area (AOI 8), the southern portion of the Old Landfill (AOI 3), and terrestrial areas in the northeastern portion of the Site. Also observed were off-site upland Background Areas (AOI 17). Observations were also made of the Holding Basin (AOI 1), the Drum Burial Area (AOI 2), and of unpaved areas surrounding buildings. The majority of the upland habitat areas on the Site contain soils that are mapped as Hinckley loamy sand (Soil No. 35). Observations made as part of the qualitative ecological assessment are summarized in following sections.

Surface Soils (AOI 14)

MACTEC personnel observed portions of this AOI located in the southwestern and northwestern areas of the property. Vegetation was generally consistent along both reaches of this AOI. Observations specific to each reach are provided below.

Southwestern portion of property: This area consists of a mixed deciduous-coniferous forest. Soils are mapped predominantly as Hinckley loamy sand, 15 to 25% slopes (Soil No. 35D). This region also includes an area mapped as Windsor loamy sand, 3 to 8 % slopes (Soil No. 67B), in the southwestern corner of the property. Red oak and eastern white pine are dominant in the canopy, with scattered individuals of black birch, white birch (*Betula papyrifera*), and white oak. Eastern hemlock saplings were observed in the understory. The shrub layer consists of scattered patches of black birch, late-low blueberry (*Vaccinium angustifolium*), and early-low blueberry (*Vaccinium pallidum*). The following species were observed in the groundcover: Canada mayflower, sedges, starflower (*Trientalis borealis*), hay-scented fern (*Dennstaedtia punctilobula*), bracken fern (*Pteridium aquilinum*), wood sorrel (*Oxalis* sp.), whorled loosestrife (*Lysimachia quadrifolia*), and bedstraw (*Galium* sp.). This area contains a thick leaf litter consisting of pine needles and leaves. Evidence of red squirrel feeding was observed.

Northwestern portion of property: Soils in this area are mapped as Hinckley loamy sand, 3 to 8 % slopes (Soil No. 35B). MACTEC personnel observed this forested area in the vicinity of monitoring wells GZW6-2 and GZW6-3. This portion of the property has a canopy dominated by red maple, oak, and eastern white pine. Black birch trees are present along the eastern edge of this area. Black oak (*Quercus velutina*) and white oak saplings were observed in the understory. The shrub and groundcover layers are generally sparse. A thick leaf litter covers the ground surface. Species observed in the shrub layer included early-low blueberry, black oak, red oak, eastern white pine, black cherry, highbush blueberry, and multiflora rose. Canada mayflower, wild oats (*Uvularia sessilifolia*), striped wintergreen (*Chimaphila maculata*), bracken fern, and seedlings of red maple, red oak, eastern white pine, and nannyberry (*Viburnum lentago*) were observed in the groundcover.

Former Waste Storage Area (AOI 7)

The Former Waste Storage Area includes various paved areas surrounding Building E and wooded land to the south. This field reconnaissance refers to the wooded area of AOI 7. The northwestern portion this area, which faces Building E, is reinforced with a rip-rap wall. Soils are mapped as Hinckley loamy sand, 15 to 25% slopes (Soil No. 35D). This AOI is forested with trees of black birch and eastern white pine, with scattered red maple trees and saplings of eastern hemlock. The shrub layer contains eastern white pine, bigtooth aspen (*Populus grandidentata*), quaking aspen (*Populus tremuloides*), black cherry, and highbush blueberry. Species observed in the groundcover included Canada mayflower, deer-tongue grass, hay-scented fern, sensitive fern, and pink lady's slipper (*Cypripedium acaule*).

Sweepings and Fill Area (AOI 8)

The Sweepings and Fill Area is located in the southwestern portion of the Site. This area has a relatively open canopy and contains disturbed, mounded soils. The native soils are mapped as Hinckley loamy sand, 15 to 25% slopes (Soil No. 35D). The mounds of fill reportedly include dredged (excavated) substrate from the Cooling Water Recharge Pond. A pile consisting of brush and soil was observed at the southwestern corner of this AOI. The groundcover contains large patches of crown vetch (*Coronilla varia*) with scattered patches of silvery cinquefoil (*Potentilla argentea*). Other species observed in the groundcover included sedges, bindweed, jewelweed, common mullein (*Verbascum thapsus*), common cinquefoil (*Potentilla simplex*), sheep sorrel (*Rumex acetosella*), common mugwort (*Artemisia vulgaris*), hay-scented fern, and deer-tongue grass. Shrubs are sparsely scattered throughout this area. Species observed in the shrub layer included highbush blackberry (*Rubus allegheniensis*), red oak, glossy buckthorn, and eastern white pine. Evidence of deer grazing was observed. Cottonwood (*Populus deltoides*) and black locust (*Robinia pseudoacacia*) saplings are present in the canopy along the edges of this AOI.

Old Landfill (AOI 3)

The northern portion of the area referred to as the Old Landfill includes a temporary infiltration cover that immediately borders the Sphagnum Bog along a portion of its south shore. Soils east and west of the covered area are sandy and are sparsely vegetated with plants typical of sandy, disturbed areas, including common mugwort and bristly sarsaparilla (*Aralia hispida*). Soils are mapped as Hinckley loamy sand, 25 to 35% slopes (Soil No. 35E), except for the southwestern portion of this AOI, which is mapped as sandy Udorthents (Soil No. 5). MACTEC personnel also observed the terrestrial habitat associated with the southern portion of the Old Landfill. This area is located south of a perimeter fence that was installed in 2002 (concurrent with the construction of the cover) to limit access to the landfilled area. It is forested and contains some open areas with disturbed soils. Black birch, eastern hemlock, and eastern white pine are present in the canopy, with saplings of black birch, red maple, and eastern white pine. Shrubs of black birch, glossy buckthorn, sweet fern (*Comptonia peregrina*), and

deerberry (*Vaccinium stamineum*) were observed. Species observed in the groundcover included sedges, hay-scented fern, common cinquefoil, Canada mayflower, striped wintergreen, common speedwell (*Veronica officinalis*), and pink lady's slipper. Deer scat was observed in this area.

Upland Areas in Northeastern Portion of Site

MACTEC personnel observed forested terrestrial habitat areas located south and east of the Northeast Wetland. Soils are mapped as Hinckley loamy sand, 25 to 35% slopes (Soil No. 35E). Vegetation located along the slope south of the Northeast Wetland and north of paved areas is dominated by a canopy of red maple, eastern white pine, red oak, white birch, and black birch, with saplings of American elm and white birch. Shrubs observed in this area included American elm, multiflora rose, black raspberry, tree-of-heaven (*Ailanthus altissima*), black cherry, glossy buckthorn, poison ivy, and dense entanglements of oriental bittersweet (*Celastrus orbiculatus*). Common mullein and butter-and-eggs (*Linaria vulgaris*) were observed in the groundcover near the edge of pavement. The forested area east of the Northeast Wetland, in the vicinity of the on-site Pavement Drain Outfall (AOI 9), contains a canopy of black birch and black oak trees, with shrubs of eastern white pine, glossy buckthorn, and eastern hemlock.

Bordering Woodland Areas (Off-site)

MACTEC personnel observed the forested areas located immediately south and southwest of the Site to provide additional observational perspective on the ecology of the Site. These areas contain a canopy of eastern white pine, black oak, white oak, and red oak, with saplings of black birch and eastern hemlock. The shrub layer contains large patches of black huckleberry (*Gaylussacia baccata*), with scattered patches of early-low blueberry, and scattered individuals of eastern white pine, black birch, and white oak. Species observed in the groundcover included Canada mayflower, clubmosses (*Lycopodium* sp.), bracken fern, Indian pipe (*Monotropa uniflora*), pink lady's slipper, and seedlings of red oak, eastern white pine, and red maple. Soils are mapped as Hinckley loamy sand, 15 to 25% slopes (Soil No. 35D) and 3 to 8% slopes (Soil No. 35B). Scat, characteristic of fox or coyote, was observed in this area.

Holding Basin (AOI 1)

MACTEC personnel observed soils and vegetation immediately surrounding the Holding Basin, a capped AOI located south of the Drum Burial Area. Areas adjacent to the Holding Basin contain disturbed, sandy soils and are vegetated with grasses and white clover. A small patch of common reed (*Phragmites australis*) was observed along the northwestern corner of this AOI. Soils in the vicinity of AOI 1 are mapped as sandy Udorthents (Soil No. 5).

Drum Burial Area (AOI 2)

The Drum Burial Area is located immediately north of the Holding Basin (AOI 1) and immediately south of the Cooling Water Recharge Pond (AOI 4). Drummed solid waste was reportedly placed in a trench excavation in this area circa 1968. An excavation is planned as part of the RI to exhume the drums. The southernmost tip of the Cooling Water Recharge Pond is included in this AOI. Soils in the Drum Burial Area are disturbed and are vegetated with grasses, white clover (*Trifolium repens*), Japanese knotweed (*Polygonum cuspidatum*), crown vetch, horsetail (*Equisetum* sp.), goldenrod (*Solidago* sp.), sensitive fern, common evening primrose (*Oenothera biennis*), and chickweed (*Stellaria* sp.); with a small number of shrubs, including Morrow's honeysuckle and black birch. Soils are mapped as Hinckley loamy sand, 25 to 35% slopes (Soil No. 35E).

Unpaved Areas Surrounding Buildings

The following vegetative species were observed in unpaved areas adjacent to the on-site buildings: crown vetch, grasses, common mugwort, spotted knapweed (*Centaurea maculosa*), goldenrod, curled dock (*Rumex crispus*), pokeweed (*Phytolacca americana*), common evening primrose, and shrubs of tree-of-heaven, autumn olive (*Elaeagnus umbellata*), and bigtooth aspen. Areas in the vicinity of the on-site buildings are mapped as Merrimac-Urban land Complex, 0 to 8% slopes (Soil No. 261).

3.3   WILDLIFE OBSERVED ON SITE

According to Starmet Corporation personnel, mammalian wildlife observed on-site include white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), coyote (*Canis latrans*), fox (*Vulpes vulpes*), and woodchuck (*Marmota monax*). During the on-site ecological assessment, MACTEC personnel observed white-tailed deer on two occasions (along the edge of the Sphagnum Bog and in the Northeast Wetland). Numerous signs of deer were observed throughout the Site, including tracks, scat, and grazed plants. On May 20, 2004, MACTEC personnel observed what appeared to be a woodchuck south of Building E. On May 21, 2004, MACTEC personnel observed an eastern cottontail north of the Holding Basin. Scat, belonging to fox or possibly coyote was observed in AOI 17. Red squirrel (*Tamiasciurus hudsonicus*), gray squirrel (*Sciurus carolinensis*), and chipmunk (*Tamias striatus*) were also observed on site.

The following avian species were identified on site based on visual observation and/or vocalizations: mourning dove (*Zenaida macroura*), eastern wood-pewee (*Contopus virens*), northern cardinal (*Cardinalis cardinalis*), eastern phoebe (*Sayornis phoebe*), black-capped chickadee (*Parus atricapillus*), American crow (*Corvus brachyrhynchos*), European starling (*Sturnus vulgaris*), Baltimore oriole (*Icterus galbula*), song sparrow (*Melospiza melodia*), American goldfinch (*Carduelis tristis*), blue jay (*Cyanocitta cristata*), tufted titmouse (*Parus bicolor*), red-shouldered hawk (*Buteo lineatus*), and

American robin (*Turdus migratorius*). In addition, evidence of woodpecker was observed along the perimeter of the Sphagnum Bog.

Reptiles and amphibians observed on site include garter snakes (observed in the Sweepings and Fill Area and Cooling Water Recharge Pond), bullfrogs (observed in the Cooling Water Recharge Pond), and wood frogs (tadpoles observed in the Northeast Wetland). In addition, movements strongly indicative of tadpoles were observed along the western edge of the Sphagnum Bog.

4.0   IDENTIFICATION AND ASSESSMENT OF POTENTIAL BACKGROUND REFERENCE LOCATIONS

A background characterization program will be performed as part of the RI to characterize the concentrations of metals, radionuclides, and semi-volatile organic chemicals that exist in similar ecological settings in the vicinity of the NMI Site, but are remote from likely measurable impacts from contamination historically released from the NMI Site. This background characterization is necessary to complete the RI investigation, complete the risk assessment and support risk management decisions, and to support the feasibility study.

Background conditions will be characterized for analytical parameters by sampling soil, sediment, and/or surface water, as described in the Field Sampling Plan for AOI 17 (MACTEC, 2003). Background reference locations for wetland areas will also be used as ecological reference areas if additional study to support the Baseline Ecological Risk Assessment is needed, such as toxicity testing, benthic community survey, and/or biological sampling.

To support these various uses of the background characterization information, it is important that the background reference locations be matched as closely as reasonably possible to the conditions at the Nuclear Metals Site. To this end, candidate background locations were identified for the Sphagnum Bog, Northeast Wetland, Cooling Water Recharge Pond, and upland areas of the Site providing terrestrial habitat. MACTEC did not identify background river locations because upstream/upwind sampling can be performed in the Assabet River.

Potential background locations were identified and assessed based on similarity to on-site areas in respect to soil type, dominant vegetation, NWI classification, hydrology, topography/slope, size/shape, location, and other considerations. Geographic Information System (GIS) software was utilized to initially identify prospective areas based on NWI classification, topography, hydrology, location, and size. Candidate locations were preferentially selected from public lands, if a suitable match could be found. Areas near the Site to the east were generally avoided since this was inferred to be the predominant downwind direction from the Site. Mapped soils data obtained from the USDA Natural Resources Conservation Service Middlesex County Interim Soil Survey Report (1995) were used identify locations with similar soil types. Locations with appropriate criteria

were then visited by MACTEC personnel to record further characteristics of these areas, including vegetative structure and composition, hydrology, and other location-specific observations. The following sections summarize the areas investigated and compare the attributes of these potential reference areas to those of the respective on-site AOIs.

4.1   Sphagnum Bog

MACTEC personnel visited prospective bog reference locations in the towns of Concord, Westford, Stow, and Hudson. Observations were made at eight bogs (Figures 9A, 9B, and 9C). Table 4 summarizes the characteristics of each of the visited locations as well as the characteristics of the on-site bog. A ninth area, Nut Meadow Bog, located east of Jennie Dugan Road in Concord, was investigated but not visited since it would require access through private residential properties.

In general, GIS was used to identify locations with an NWI code of PSS3Ba. However, the larger Gardner Hill bog was identified based on field observations, and Thoreau's bog was identified based on town conservation information. Four of the bogs that were observed (Thoreau's Bog, the Walden Pond bog, and the two Adams/Wright bogs) are located northeast or southeast (and potentially downwind) of the Site (Figure 9B). However, these bogs are located greater than 3.5 miles from the Site, and therefore, are judged unlikely to have received measurable site impacts. The other four bogs (Westford bog, Hudson bog, and the two Gardner Hill bogs) are located north or southwest of the Site (Figures 9A and 9C).

With the exception of the Adams/Wright Bog No. 1, all of the bog locations that were observed had the same mapped soil type as the on-site Sphagnum Bog (Freetown muck). The Westford bog (Figures 9C and 10) appeared most similar to the Sphagnum Bog in respect to size, vegetative structure, moat structure, and vegetative species (Table 4). Based on the information collected, MACTEC recommends that the Westford bog be used as the reference area for the Sphagnum Bog. According to public information, the Westford bog is located on property owned by East Boston Camps. If sampling cannot be conducted at the Westford bog (i.e., owner permission is not obtained), the Hudson bog could be used as an alternative reference location. The Hudson bog (Figures 9A and 11) is a larger wetland area than the Sphagnum Bog, appears slightly drier, does not have a complete moat, but has a similar vegetative structure and plant community.

The other candidate bog locations viewed by MACTEC personnel had fewer characteristics in common with the Sphagnum Bog, and differed notably from the on-site bog in respect to hydrology, size, vegetative communities, and/or soil type.

4.2   Cooling Water Recharge Pond

The following prospective reference locations were identified for the Cooling Water Recharge Pond: the Maynard High School pond in Maynard, the Durant Avenue Retention pond in Maynard, a pond located north of Silver Hill Road in Concord, a pond located on Great Hill Conservation land in Acton, a pond located north of the intersection

of Parker Street and Robert Road in Acton, a pond located northeast of the intersection of Longfellow and Ford Roads in Sudbury, and a pond located north of the Maynard Industrial Park in Maynard (Figures 12A and 12B). Table 5 summarizes information collected from each of these areas. GIS was utilized to identify permanently flooded, excavated ponds with an NWI code of PUBHx. All ponds that were identified are located upwind of the Site except for the Silver Hill Road pond (Figure 12B), which is located 6.3 miles northeast (and potentially downwind) of the Site. However, given this distance, the Silver Hill Road pond is unlikely to have been impacted from the Site.

The Maynard High School pond shares the greatest number of characteristics in common with the Cooling Water Recharge Pond (Figures 12A and 13). It is surrounded by moderately sloping topography and soils that are mapped as loamy sand, and has vegetation that most closely matches that of the Cooling Water Recharge Pond. Additionally, the Maynard High School Pond and the Cooling Water Recharge Pond are similar in size and are both partially shaded by vegetation. Both ponds support populations of bullfrogs. Based on these characteristics, MACTEC recommends that the Maynard High School pond be used as the reference location for the Cooling Water Recharge Pond.

Other ponds that could be potentially used as reference locations for the Cooling Water Recharge Pond are the Durant Avenue Retention pond (Figure 14) and the pond north of Silver Hill Road (Figure 15). Both ponds are considerably larger than the Cooling Water Recharge Pond and are less shaded. The Durant Avenue Retention pond is surrounded by vegetation that is somewhat similar to that of the Cooling Water Recharge Pond. However, topography surrounding the Durant Avenue Retention pond is relatively flat and soils in the vicinity are mapped as muck and sandy loam. The Silver Hill Road pond is surrounded by soils that are mapped as Hinckley loamy sand, the same soil type as the Cooling Water Recharge Pond. However, the vegetation surrounding this pond is less similar to that of the Cooling Water Recharge Pond.

The other ponds observed would not make appropriate reference locations. The Great Hill Conservation Area pond receives high recreational use and contains fish; the Robert/Parker and Longfellow/Ford ponds are located on private residential land and are completely surrounded by manicured lawns; and the Maynard Industrial Park pond may have formerly received industrial discharge.

4.3 NORTHEAST WETLAND

MACTEC personnel observed several candidate reference areas for the Northeast Wetland (Figures 16A, 16B, and 16C). The Northeast Wetland is a small isolated wetland area located adjacent to a roadway. One portion of this wetland contains a vernal pool surrounded by a forested area; the other portion contains saturated soils, an open canopy, and primarily herbaceous vegetation. Topography is moderately sloping to the wetland. Wetland areas with similar characteristics were difficult to locate. Vernal pool and potential vernal pool GIS data layers were utilized to identify potential locations. NWI mapping information was used to a lesser degree, since the wetland types observed

in the field did not always agree with the mapped NWI code. Many of the candidate areas observed were determined to be inappropriate and not further assessed.

Table 6 summarizes characteristics of some of the candidate wetland areas that were assessed. All of the areas investigated are located greater than 2 miles from the Site and are located near or adjacent to a roadway. None of the areas investigated are located downwind of the Site. As shown in Table 6, topography is relatively flat or gently sloping to the wetland at all areas investigated. No appropriate wetland areas could be identified that were surrounded by moderately sloping topography. Two wetland areas located north of the Conant Well in Acton have characteristics that most closely resemble the Northeast Wetland, including a vernal pool-like portion, soils that are mapped as Swansea muck, and plant species and vegetative structure similar to that of the vernal-pool portion of the Northeast Wetland (Figures 17A and 17B). On June 15, 2004, MACTEC personnel observed ponded water in the more northern of these wetland areas (Location 1), but no standing water in the wetland to the south (Location 2). Water-stained leaves were observed at Location 2, indicating that this area likely contained standing water earlier in the season. The vernal pool-portion of the Northeast Wetland was viewed on the same date, and appeared similar to Location 2, in that it contained water-stained leaves and no standing water. Due to these similarities, MACTEC recommends that the Location 2 wetland, located north of the Conant Well in Acton, be used as the wetland reference location.

The Durant Avenue pool in Maynard (Figure 18) and a wetland located on Whittier Conservation land in Acton (Figure 19) have fewer characteristics in common with the Northeast Wetland. The Durant Avenue pool is vernal pool-like and has soils that are mapped as Swansea muck. However, the vegetation does not closely match that of the Northeast Wetland. The Whittier Conservation land wetland is vernal pool-like and has vegetation similar to that of the Northeast Wetland; however, the soils are mounded and appear disturbed and are mapped as a different soil type. Potential wetland reference areas were also observed at the following locations: near the Assabet River Rail Trail in Maynard, along Hildreth Street in Westford, along Old County Road in Hudson, on Nagog Hill Conservation land in Acton, and in Sudbury State Forest in Stow. These areas are even less similar to the Northeast Wetland, and have major differences in vegetation, soil type, and/or hydrology.

4.4   UPLAND SITE SOILS

Three candidate reference areas were identified with the same soil type as the on-site upland soils (Hinckley loamy sand). Candidate reference locations were identified from the Gardner Hill Town Forest in Stow, open space located east of Taylor Road and west of the Green Meadow School in Maynard, and open space in the vicinity of the Assabet Wells property in Acton (Figure 20). Table 7 summarizes information collected from these areas. All three areas investigated are located upwind of the Site. The Gardner Hill Town Forest is located the greatest distance from the Site (3.7 miles to the southwest) and contains vegetation that most closely matches the upland Site vegetation; therefore, MACTEC recommends that this area be used as the upland reference. The Taylor Road

area contains vegetation that is less similar to upland areas of the Site, but could potentially be used as an alternative reference location. Due to its close proximity to the Site (approximately 0.5 miles to the northwest), and proximity to a separate defined hazardous waste Site, the Assabet Wells property would be a less appropriate reference location.

5.0   REFERENCES

Cowardin, L.M, V. Carter, F. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Prepared for U.S. Department of the Interior, Fish and Wildlife Service Office of Biological Services. December.

Jackson, S. 1995. Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act. Produced by Massachusetts Department of Environmental Protection (MADEP). March.

MACTEC, 2003. Remedial Investigation/Feasibility Study Workplan. Volume IIIb. Field Sampling Plan. Draft 12/04/03.

U.S. Department of Agriculture (USDA) Natural Resource Conservation Service. 1995. Middlesex County Massachusetts Interim Soil Survey Report. Middlesex Conservation District. July 1995, fourth edition.

U. S. Fish and Wildlife Service. . National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, St. Petersburg, FL. http://www.nwi.fws.gov. Accessed May 5, 2004.

ATTACHMENTS